CHAPTER 14

EXTERIOR WALLS

SECTION 1401
GENERAL

1401.1 Scope. The provisions of this chapter shall establish the minimum requirements for exterior walls, exterior wall coverings, exterior wall openings, exterior windows and doors, architectural trim, balconies and bay windows.

> **Exception:** Buildings and structures located within the high-velocity hurricane zone shall comply with the provisions of Sections 1403.7 and 1408.

SECTION 1402
DEFINITIONS

1402.1 General. The following words and terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meanings shown herein.

ADHERED MASONRY VENEER. Veneer secured and supported through the adhesion of an approved bonding material applied to an approved backing.

ANCHORED MASONRY VENEER. Veneer secured with approved mechanical fasteners to an approved backing.

BACKING. The wall or surface to which the veneer is secured.

EXTERIOR WALL. A wall, bearing or nonbearing, that is used as an enclosing wall for a building, other than a fire wall, and that has a slope of 60 degrees (1.05 rad) or greater with the horizontal plane.

EXTERIOR WALL COVERING. A material or assembly of materials applied on the exterior side of exterior walls for the purpose of providing a weather-resisting barrier, insulation or for aesthetics, including but not limited to, veneers, siding, exterior insulation and finish systems, architectural trim and embellishments such as cornices, soffits, facias, gutters and leaders.

EXTERIOR WALL ENVELOPE. A system or assembly of exterior wall components, including exterior wall finish materials, that provides protection of the building structural members, including framing and sheathing materials, and conditioned interior space, from the detrimental effects of the exterior environment.

FIBER CEMENT SIDING. A manufactured, fiber-reinforcing product made with an inorganic hydraulic or calcium silicate binder formed by chemical reaction and reinforced with organic or inorganic nonasbestos fibers, or both. Additives that enhance manufacturing or product performance are permitted. Fiber cement siding products have either smooth or textured faces and are intended for exterior wall and related applications.

METAL COMPOSITE MATERIAL (MCM). A factory-manufactured panel consisting of metal skins bonded to both faces of a plastic core.

METAL COMPOSITE MATERIAL (MCM) SYSTEM. An exterior wall finish system fabricated using MCM in a specific assembly including joints, seams, attachments, substrate, framing and other details as appropriate to a particular design.

VENEER. A facing attached to a wall for the purpose of providing ornamentation, protection or insulation, but not counted as adding strength to the wall.

VINYL SIDING. A shaped material, made principally from rigid polyvinyl chloride (PVC), that is used as an exterior wall covering.

WATER-RESISTIVE BARRIER. A material behind an exterior wall covering that is intended to resist liquid water that has penetrated behind the exterior covering from further intruding into the exterior wall assembly.

SECTION 1403
PERFORMANCE REQUIREMENTS

1403.1 General. The provisions of this section shall apply to exterior walls, wall coverings and components thereof.

1403.2 Weather protection. Exterior walls shall provide the building with a weather-resistant exterior wall envelope. The exterior wall envelope shall include flashing, as described in Section 1405.3. The exterior wall envelope shall be designed and constructed in such a manner as to prevent the accumulation of water within the wall assembly by providing a water-resistive barrier behind the exterior veneer, as described in Section 1404.2 and a means for draining water that enters the assembly to the exterior. All exterior finishes shall be applied in accordance with the manufacturer's specifications or installation instructions. Protection against condensation in the exterior wall assembly shall be provided in accordance with Chapter 13 of the *Florida Building Code, Building*.

Exceptions:

1. A weather-resistant exterior wall envelope shall not be required over concrete or nonporous masonry walls designed in accordance with Chapters 19 and 21, respectively.
2. Compliance with the requirements for a means of drainage, and the requirements of Sections 1405.2 and 1405.3, shall not be required for an exterior wall envelope that has been demonstrated through testing to resist wind-driven rain, including joints, penetrations and intersections with dissimilar materials, in accordance with ASTM E 331 under the following conditions:
   - 2.1. Exterior wall envelope test assemblies shall include at least one opening, one control joint, one wall/eave interface and one wall sill. All tested openings and penetrations shall be representative of the intended end-use configuration.

2.2. Exterior wall envelope test assemblies shall be at least 4 feet by 8 feet (1219 mm by 2438 mm) in size.

2.3. Exterior wall envelope assemblies shall be tested at a minimum differential pressure of 6.24 pounds per square foot (psf) (0.297 kN/m^2).

2.4. Exterior wall envelope assemblies shall be subjected to a minimum test exposure duration of 2 hours.

The exterior wall envelope design shall be considered to resist wind-driven rain where the results of testing indicate that water did not penetrate control joints in the exterior wall envelope, joints at the perimeter of openings or intersections of terminations with dissimilar materials.

1403.3 Structural. Exterior walls, and the associated openings, shall be designed and constructed to resist safely the superimposed loads required by Chapter 16.

1403.4 Fire resistance. Exterior walls shall be fire-resistance rated as required by other sections of this code with opening protection as required by Chapter 7.

1403.5 Flood resistance. This code specifically defers to the authority granted to local government by Title 44 CFR, Sections 59 and 60. This code is not intended to supplant or supercede local ordinances adopted pursuant to that authority, nor are local floodplain management ordinances to be deemed amendments to the code.

1403.6 Flood resistance for high-velocity wave action areas. Reserved.

1403.7 In order to provide for inspection for termite infestation, clearance between exterior wall coverings and final earth grade on the exterior of a building shall not be less than 6 inches (152 mm).

Exceptions:

1. Paint or decorative cementitious finish less than $^5/_8$ inch (17.1 mm) thick adhered directly to the masonry foundation sidewall.
2. Access or vehicle ramps which rise to the interior finish floor elevation for the width of such ramps only.
3. A 4-inch (102 mm) inspection space above patio and garage slabs and entry areas.
4. If the patio has been soil treated for termites, the finish elevation may match the building interior finish floor elevations on masonry construction only.
5. Masonry veneers.

1403.8 Drained wall assembly over mass wall assembly. Where wood frame or other types of drained wall assemblies are constructed above mass wall assemblies, flashing or other approved drainage system shall be installed as required by Section 1405.3.

SECTION 1404 MATERIALS

1404.1 General. Materials used for the construction of exterior walls shall comply with the provisions of this section. Materials not prescribed herein shall be permitted, provided that any such alternative has been approved.

1404.2 Water-resistive barrier. Exterior walls of frame construction receiving a veneer shall be provided with a water-resistive barrier. The water-resistive barrier shall be a minimum of one layer of No. 15 asphalt felt, complying with ASTM D 226 for Type 1 felt or other approved materials, shall be attached to the sheathing, with flashing as described in Section 1405.3, in such a manner as to provide a continuous water-resistive barrier behind the exterior wall veneer.

1404.2.1 Where cement plaster (stucco) is to be applied to lath over frame construction, measures shall be taken to prevent bonding between the cement plaster and the water resistive barrier. A bond break shall be provided between the water resistive barrier and the cement plaster (stucco) consisting of one of the following:

1. Two layers of an approved water-resistant barrier or
2. One layer of an approved water-resistant barrier over an approved plastic house wrap, or
3. Other approved methods or materials applied in accordance with the manufacturer's installation instructions.

1404.3 Wood. Exterior walls of wood construction shall be designed and constructed in accordance with Chapter 23.

1404.3.1 Basic hardboard. Basic hardboard shall conform to the requirements of AHA A135.4.

1404.3.2 Hardboard siding. Hardboard siding shall conform to the requirements of AHA A135.6 and, where used structurally, shall be so identified by the label of an approved agency.

1404.4 Masonry. Exterior walls of masonry construction shall be designed and constructed in accordance with this section and Chapter 21. Masonry units, mortar and metal accessories used in anchored and adhered veneer shall meet the physical requirements of Chapter 21. The backing of anchored and adhered veneer shall be of concrete, masonry, steel framing or wood framing.

1404.5 Metal. Exterior walls of formed steel construction, structural steel or lightweight metal alloys shall be designed in accordance with Chapters 22 and 20, respectively.

1404.5.1 Aluminum siding. Aluminum siding shall conform to the requirements of AAMA 1402.

1404.5.2 Cold-rolled copper. Copper shall conform to the requirements of ASTM B 370.

1404.5.3 Lead-coated copper. Lead-coated copper shall conform to the requirements of ASTM B 101.

1404.6 Concrete. Exterior walls of concrete construction shall be designed and constructed in accordance with Chapter 19.

1404.7 Glass-unit masonry. Exterior walls of glass-unit masonry shall be designed and constructed in accordance with Chapter 21.

1404.8 Plastics. Plastic panel, apron or spandrel walls as defined in this code shall not be limited in thickness, provided that such plastics and their assemblies conform to the requirements of Chapter 26 and are constructed of approved weather-resistant materials of adequate strength to resist the wind loads for cladding specified in Chapter 16.

1404.9 Vinyl siding. Vinyl Siding and soffit shall conform to the requirements of ASTM D 3679, ASTM D 4477 and the manufacturer's installation instructions.

1404.9.1 Labeling. Vinyl siding shall be labeled as conforming to the requirements of ASTM D 3679.

1404.10 Fiber cement siding. Fiber cement siding shall conform to the requirements of ASTM C 1186 and shall be so identified on labeling listing an approved quality control agency.

SECTION 1405
INSTALLATION OF WALL COVERINGS

1405.1 General. Exterior wall coverings shall be designed and constructed in accordance with the applicable provisions of this section.

1405.2 Weather protection. Exterior walls shall provide weather protection for the building. The materials of the minimum nominal thickness specified in Table 1405.2 shall be acceptable as approved weather coverings.

1405.3 Flashing. Flashing shall be installed in such a manner so as to prevent moisture from entering the wall or to redirect it to the exterior. Flashing shall be installed at the perimeters of exterior door and window assemblies, penetrations and terminations of exterior wall assemblies, exterior wall intersections with roofs, chimneys, porches, decks, balconies and similar projections and at built-in gutters and similar locations where moisture could enter the wall. Flashing with projecting flanges shall be installed on both sides and the ends of copings, under sills and continuously above projecting trim.

1405.3.1 Exterior wall pockets. In exterior walls of buildings or structures, wall pockets or crevices in which moisture can accumulate shall be avoided or protected with caps or drips, or other approved means shall be provided to prevent water damage.

1405.3.2 Masonry. Flashing and weep holes shall be located in the first course of masonry above finished ground level above the foundation wall or slab, and other points of support, including structural floors, shelf angles and lintels where anchored veneers are designed in accordance with Section 1405.5.

1405.4 Wood veneers. Wood veneers on exterior walls of buildings of Type I, II, III and IV construction shall be not less than 1 inch (25 mm) nominal thickness, 0.438-inch (11.1 mm) exterior hardboard siding or 0.375-inch (9.5 mm) exterior-type wood structural panels or particleboard and shall conform to the following:

TABLE 1405.2
MINIMUM THICKNESS OF WEATHER COVERINGS

COVERING TYPE	MINIMUM THICKNESS (inches)
Adhered masonry veneer	0.25
Aluminum siding	0.019
Anchored masonry veneer	2.625
Asbestos-cement boards	0.125
Asbestos shingles	0.156
Cold-rolled copper[d]	0.0216 nominal
Copper shingles[d]	0.0162 nominal
Exterior plywood (with sheathing)	0.313
Exterior plywood (without sheathing)	See Section 2304.6
Fiber cement lap siding	0.25[c]
Fiber cement panel siding	0.25[c]
Fiberboard siding	0.5
Glass-fiber reinforced concrete panels	0.375
Hardboard siding[c]	0.25
High-yield copper[d]	0.0162 nominal
Lead-coated copper[d]	0.0216 nominal
Lead-coated high-yield copper	0.0162 nominal
Marble slabs	1
Particleboard (with sheathing)	See Section 2304.6
Particleboard (without sheathing)	See Section 2304.6
Precast stone facing	0.625
Steel (approved corrosion resistant)	0.0149
Stone (cast artificial)	1.5
Stone (natural)	2
Structural glass	0.344
Stucco or exterior portland cement plaster	
Three-coat work over:	
Metal plaster base	0.875[b]
Unit masonry	0.625[b]
Cast-in-place or precast concrete	0.625[b]
Two-coat work over:	
Unit masonry	0.5[b]
Cast-in-place or precast concrete	0.375[b]
Terra cotta (anchored)	1
Terra cotta (adhered)	0.25
Vinyl siding	0.035
Wood shingles	0.375
Wood siding (without sheathing)[a]	0.5

For SI: 1 inch = 25.4 mm.

a. Wood siding of thicknesses less than 0.5 inch shall be placed over sheathing that conforms to Section 2304.6.
b. Exclusive of texture.
c. As measured at the bottom of decorative grooves.
d. 16 ounces per square foot for cold-rolled copper and lead-coated copper, 12 ounces per square foot for copper shingles, high-yield copper and lead-coated high-yield copper.

1. The veneer shall not exceed three stories in height, measured from the grade plane. Where fire-retardant-treated wood is used, the height shall not exceed four stories.
2. The veneer is attached to or furred from a noncombustible backing that is fire-resistance rated as required by other provisions of this code.
3. Where open or spaced wood veneers (without concealed spaces) are used, they shall not project more than 24 inches (610 mm) from the building wall.

1405.5 Anchored masonry veneer. Anchored masonry veneer shall comply with the provisions of Sections 1405.5, 1405.6, 1405.7 and 1405.8 and Sections 6.1 and 6.2 of ACI 530/ASCE 5/TMS 402.

1405.5.1 Tolerances. Anchored masonry veneers in accordance with Chapter 14 are not required to meet the tolerances in Article 3.3 G1 of ACI 530.1/ASCE 6/TMS 602.

1405.5.2 Seismic requirements. Reserved.

1405.6 Stone veneer. Stone veneer units not exceeding 10 inches (254 mm) in thickness shall be anchored directly to masonry, concrete or to stud construction by one of the following methods:

1. With concrete or masonry backing, anchor ties shall be not less than 0.1055-inch (2.68 mm) corrosion-resistant wire, or approved equal, formed beyond the base of the backing. The legs of the loops shall be not less than 6 inches (152 mm) in length bent at right angles and laid in the mortar joint, and spaced so that the eyes or loops are 12 inches (305 mm) maximum on center (o.c.) in both directions. There shall be provided not less than a 0.1055-inch (2.68 mm) corrosion-resistant wire tie, or approved equal, threaded through the exposed loops for every 2 square feet (0.2 m^2) of stone veneer. This tie shall be a loop having legs not less than 15 inches (381 mm) in length bent so that it will lie in the stone veneer mortar joint. The last 2 inches (51 mm) of each wire leg shall have a right-angle bend. One-inch (25 mm) minimum thickness of cement grout shall be placed between the backing and the stone veneer.
2. With stud backing, a 2-inch by 2-inch (51 by 51 mm) 0.0625-inch (1.59 mm) corrosion-resistant wire mesh with two layers of water-resistive barrier in accordance with Section 1404.2 shall be applied directly to wood studs spaced a maximum of 16 inches (406 mm) o.c. On studs, the mesh shall be attached with 2-inch-long (51 mm) corrosion-resistant steel wire furring nails at 4 inches (102 mm) o.c. providing a minimum 1.125-inch (29 mm) penetration into each stud and with 8d common nails at 8 inches (203 mm) o.c. into top and bottom plates or with equivalent wire ties. There shall be not less than a 0.1055-inch (2.68 mm) corrosion-resistant wire, or approved equal, looped through the mesh for every 2 square feet (0.2 m^2) of stone veneer. This tie shall be a loop having legs not less than 15 inches (381 mm) in length, so bent that it will lie in the stone veneer mortar joint. The last 2 inches (51 mm) of each wire leg shall have a right-angle bend. One-inch (25 mm) minimum thickness of cement grout shall be placed between the backing and the stone veneer.

1405.7 Slab-type veneer. Slab-type veneer units not exceeding 2 inches (51 mm) in thickness shall be anchored directly to masonry, concrete or stud construction. For veneer units of marble, travertine, granite or other stone units of slab form ties of corrosion-resistant dowels in drilled holes shall be located in the middle third of the edge of the units, spaced a maximum of 24 inches (610 m) apart around the periphery of each unit with not less than four ties per veneer unit. Units shall not exceed 20 square feet (1.9 m^2) in area. If the dowels are not tight fitting, the holes shall be drilled not more than 0.063 inch (1.6 mm) larger in diameter than the dowel, with the hole countersunk to a diameter and depth equal to twice the diameter of the dowel in order to provide a tight-fitting key of cement mortar at the dowel locations when the mortar in the joint has set. Veneer ties shall be corrosion-resistant metal capable of resisting, in tension or compression, a force equal to two times the weight of the attached veneer. If made of sheet metal, veneer ties shall be not smaller in area than 0.0336 by 1 inch (0.853 by 25 mm) or, if made of wire, not smaller in diameter than 0.1483-inch (3.76 mm) wire.

1405.8 Terra cotta. Anchored terra cotta or ceramic units not less than 1.625 inches (41 mm) thick shall be anchored directly to masonry, concrete or stud construction. Tied terra cotta or ceramic veneer units shall be not less than 1.625 inches (41 mm) thick with projecting dovetail webs on the back surface spaced approximately 8 inches (203 mm) o.c. The facing shall be tied to the backing wall with corrosion-resistant metal anchors of not less than No. 8 gage wire installed at the top of each piece in horizontal bed joints not less than 12 inches (305 mm) nor more than 18 inches (457 mm) o.c.; these anchors shall be secured to 0.25-inch (6.4 mm) corrosion-resistant pencil rods that pass through the vertical aligned loop anchors in the backing wall. The veneer ties shall have sufficient strength to support the full weight of the veneer in tension. The facing shall be set with not less than a 2-inch (51 mm) space from the backing wall and the space shall be filled solidly with portland cement grout and pea gravel. Immediately prior to setting, the backing wall and the facing shall be drenched with clean water and shall be distinctly damp when the grout is poured.

1405.9 Adhered masonry veneer. Adhered masonry veneer shall comply with the applicable requirements in Section 1405.9.1 and Sections 6.1 and 6.3 of ACI 530/ASCE 5/TMS 402.

1405.9.1 Interior adhered masonry veneers. Interior adhered masonry veneers shall have a maximum weight of 20 psf (0.958 kg/m^2) and shall be installed in accordance with Section 1405.9. Where the interior adhered masonry veneer is supported by wood construction, the supporting members shall be designed to limit deflection to $^1/_{600}$ of the span of the supporting members.

1405.10 Metal veneers. Veneers of metal shall be fabricated from approved corrosion-resistant materials or shall be protected front and back with porcelain enamel, or otherwise be treated to render the metal resistant to corrosion. Such veneers shall not be less than 0.0149-inch (0.378 mm) nominal thickness sheet steel mounted on wood or metal furring strips or approved sheathing on the wood construction.

1405.10.1 Attachment. Exterior metal veneer shall be securely attached to the supporting masonry or framing members with corrosion-resistant fastenings, metal ties or by other approved devices or methods. The spacing of the fastenings or ties shall not exceed 24 inches (610 mm) either vertically or horizontally, but where units exceed 4 square feet (0.4 m^2) in area there shall be not less than four attachments per unit. The metal attachments shall have a cross-sectional area not less than provided by W 1.7 wire. Such attachments and their supports shall be capable of resisting a horizontal force in accordance with the wind loads specified in Section 1609, but in no case less than 20 psf (0.958 kg/m^2).

1405.10.2 Weather protection. Metal supports for exterior metal veneer shall be protected by painting, galvanizing or by other equivalent coating or treatment. Wood studs, furring strips or other wood supports for exterior metal veneer shall be approved pressure-treated wood or protected as required in Section 1403.2. Joints and edges exposed to the weather shall be caulked with approved durable waterproofing material or by other approved means to prevent penetration of moisture.

1405.10.3 Backup. Masonry backup shall not be required for metal veneer except as is necessary to meet the fire-resistance requirements of this code.

1405.10.4 Grounding. Grounding of metal veneers on buildings shall comply with the requirements of Chapter 27.

1405.11 Glass veneer. The area of a single section of thin exterior structural glass veneer shall not exceed 10 square feet (0.93 m^2) where it is not more than 15 feet (4572 mm) above the level of the sidewalk or grade level directly below, and shall not exceed 6 square feet (0.56 m^2) where it is more than 15 feet (4572 mm) above that level.

1405.11.1 Length and height. The length or height of any section of thin exterior structural glass veneer shall not exceed 48 inches (1219 mm).

1405.11.2 Thickness. The thickness of thin exterior structural glass veneer shall be not less than 0.344 inch (8.7 mm).

1405.11.3 Application. Thin exterior structural glass veneer shall be set only after backing is thoroughly dry and after application of an approved bond coat uniformly over the entire surface of the backing so as to effectively seal the surface. Glass shall be set in place with an approved mastic cement in sufficient quantity so that at least 50 percent of the area of each glass unit is directly bonded to the backing by mastic not less than 0.25 inch (6.4 mm) thick and not more than 0.625 inch (15.9 mm) thick. The bond coat and mastic shall be evaluated for compatibility and shall bond firmly together.

1405.11.4 Installation at sidewalk level. Where glass extends to a sidewalk surface, each section shall rest in an approved metal molding, and be set at least 0.25 inch (6.4 mm) above the highest point of the sidewalk. The space between the molding and the sidewalk shall be thoroughly caulked and made water tight.

1405.11.4.1 Installation above sidewalk level. Where thin exterior structural glass veneer is installed above the level of the top of a bulkhead facing, or at a level more than 36 inches (914 mm) above the sidewalk level, the mastic cement binding shall be supplemented with approved nonferrous metal shelf angles located in the horizontal joints in every course. Such shelf angles shall be not less than 0.0478-inch (1.2 mm) thick and not less than 2 inches (51 mm) long and shall be spaced at approved intervals, with not less than two angles for each glass unit. Shelf angles shall be secured to the wall or backing with expansion bolts, toggle bolts or by other approved methods.

1405.11.5 Joints. Unless otherwise specifically approved by the building official, abutting edges of thin exterior structural glass veneer shall be ground square. Mitered joints shall not be used except where specifically approved for wide angles. Joints shall be uniformly buttered with an approved jointing compound and horizontal joints shall be held to not less than 0.063 inch (1.6 mm) by an approved nonrigid substance or device. Where thin exterior structural glass veneer abuts nonresilient material at sides or top, expansion joints not less than 0.25 inch (6.4 mm) wide shall be provided.

1405.11.6 Mechanical fastenings. Thin exterior structural glass veneer installed above the level of the heads of show windows and veneer installed more than 12 feet (3658 mm) above sidewalk level shall, in addition to the mastic cement and shelf angles, be held in place by the use of fastenings at each vertical or horizontal edge, or at the four corners of each glass unit. Fastenings shall be secured to the wall or backing with expansion bolts, toggle bolts or by other methods. Fastenings shall be so designed as to hold the glass veneer in a vertical plane independent of the mastic cement. Shelf angles providing both support and fastenings shall be permitted.

1405.11.7 Flashing. Exposed edges of thin exterior structural glass veneer shall be flashed with overlapping corrosion-resistant metal flashing and caulked with a waterproof compound in a manner to effectively prevent the entrance of moisture between the glass veneer and the backing.

1405.12 Exterior windows and doors. Windows and doors installed in exterior walls shall conform to the testing and performance requirements of Section 1714.5.

1405.12.1 Installation. Windows and doors shall be installed in accordance with approved manufacturer's instructions. Fastener size and spacing shall be provided in such instructions and shall be calculated based on maximum loads and spacing used in the tests.

1405.12.2 Window sills. In Occupancy Groups R-2 and R-3, one- and two-family and multiple-family dwellings, where the opening of the sill portion of an operable window is located more than 72 inches (1829 mm) above the finished grade or other surface below, the lowest part of the clear opening of the window shall be at a height not less than 24 inches (610 mm) above the finished floor surface of the room in which the window is located. Glazing between the floor and a height of 24 inches (610 mm) shall be fixed or have openings through which a 4-inch (102 mm) diameter sphere cannot pass.

Exception: Openings that are provided with window guards that comply with ASTM F 2006 or F 2090.

1405.13 Vinyl siding. Vinyl siding conforming to the requirements of this section and complying with ASTM D 3679, and ASTM D 4477 in accordance with the manufacturer's installation instructions shall be permitted on exterior walls of buildings of Type V construction located in areas where the basic wind speed specified in Chapter 16 does not exceed 100 miles per hour (45 m/s) and the building height is less than or equal to 40 feet (12 192 mm) in Exposure C. Where construction is located in areas where the basic wind speed exceeds 100 miles per hour (45 m/s), or building heights are in excess of 40 feet (12 192 mm), tests or calculations indicating compliance with Chapter 16 shall be submitted. Vinyl siding shall be secured to the building so as to provide weather protection for the exterior walls of the building.

1405.13.1 Application. The siding shall be applied over sheathing or materials listed in Section 2304.6. Siding shall be applied to conform with the water-resistive barrier requirements in Section 1403. Siding and accessories shall be installed in accordance with approved manufacturer's instructions. Unless otherwise specified in the approved manufacturer's instructions, nails used to fasten the siding and accessories shall have a minimum 0.313-inch (7.9 mm) head diameter and 0.125-inch (3.18 mm) shank diameter. The nails shall be corrosion resistant and shall be long enough to penetrate the studs or nailing strip at least 0.75 inch (19 mm). Where the siding is installed horizontally, the fastener spacing shall not exceed 16 inches (406 mm) horizontally and 12 inches (305 mm) vertically. Where the siding is installed vertically, the fastener spacing shall not exceed 12 inches (305 mm) horizontally and 12 inches (305 mm) vertically.

1405.14 Cement plaster. Cement plaster applied to exterior walls shall conform to the requirements specified in Chapter 25.

1405.15 Fiber cement siding. Fiber cement siding complying with Section 1404.10 shall be permitted on exterior walls of Type I, II, III, IV and V construction for wind pressure resistance or wind speed exposures as indicated in the manufacturer's compliance report and approved installation instructions. Where specified, the siding shall be installed over sheathing or materials listed in Section 2304.6 and shall be installed to conform to the water-resistive barrier requirements in Section 1403. Siding and accessories shall be installed in accordance with approved manufacturer's instructions. Unless otherwise specified in the approved manufacturer's instructions, nails used to fasten the siding to wood studs shall be corrosion-resistant round head smooth shank and shall be long enough to penetrate the studs at least 1 inch (25 mm). For metal framing, all-weather screws shall be used and shall penetrate the metal framing at least three full threads.

1405.16 Fastening. Weather boarding and wall coverings shall be securely fastened with aluminum, copper, zinc, zinc-coated or other approved corrosion-resistant fasteners in accordance with the nailing schedule in Table 2304.9.1 or the approved manufacturer's installation instructions. Shingles and other weather coverings shall be attached with appropriate standard-shingle nails to furring strips securely nailed to studs, or with approved mechanically bonding nails, except where sheathing is of wood not less than 1-inch (25 mm) nominal thickness or of wood structural panels as specified in Table 2308.9.3(3).

1405.17 Fiber cement siding.

1405.17.1 Panel siding. Panels shall be installed with the long dimension parallel to framing. Vertical joints shall occur over framing members and shall be sealed with caulking or covered with battens. Horizontal joints shall be flashed with Z-flashing and blocked with solid wood framing.

1405.17.2 Horizontal lap siding. Lap siding shall be lapped a minimum of $1^1/_4$ inches (32 mm) and shall have the ends sealed with caulking, covered with an H-section joint cover or located over a strip of flashing. Lap siding courses shall be permitted to be installed with the fastener heads exposed or concealed, according to approved manufacturers' instructions.

SECTION 1406
COMBUSTIBLE MATERIALS ON THE EXTERIOR SIDE OF EXTERIOR WALLS

1406.1 General. Section 1406 shall apply to exterior wall coverings; balconies and similar projections; and bay and oriel windows constructed of combustible materials.

1406.2 Combustible exterior wall coverings. Combustible exterior wall coverings shall comply with this section.

Exception: Plastics complying with Chapter 26.

1406.2.1 Ignition resistance. Combustible exterior wall coverings shall be tested in accordance with NFPA 268.

Exceptions:

1 Wood or wood-based products.
2. Other combustible materials covered with an exterior covering other than vinyl sidings listed in Table 1405.2.
3. Aluminum having a minimum thickness of 0.019 inch (0.48 mm).
4. Exterior wall coverings on exterior walls of Type V construction.

1406.2.1.1 Fire separation 5 feet or less. Where installed on exterior walls having a fire separation distance of 5 feet (1524 mm) or less, combustible exterior wall coverings shall not exhibit sustained flaming as defined in NFPA 268.

1406.2.1.2 Fire separation greater than 5 feet. For fire separation distances greater than 5 feet (1524 mm), an assembly shall be permitted that has been exposed to a reduced level of incident radiant heat flux in accordance with the NFPA 268 test method without exhibiting sustained flaming. The minimum fire separation distance required for the assembly shall be determined from Table 1406.2.1.2 based on the maximum tolerable level of incident radiant heat flux that does not cause sustained flaming of the assembly.

TABLE 1406.2.1.2
MINIMUM FIRE SEPARATION FOR COMBUSTIBLE VENEERS

FIRE SEPARATION DISTANCE (feet)	TOLERABLE LEVEL INCIDENT RADIANT HEAT ENERGY(kW/m^2)	FIRE SEPARATION DISTANCE (feet)	TOLERABLE LEVEL INCIDENT RADIANT HEAT ENERGY(kW/m^2)
5	12.5	16	5.9
6	11.8	17	5.5
7	11.0	18	5.2
8	10.3	19	4.9
9	9.6	20	4.6
10	8.9	21	4.4
11	8.3	22	4.1
12	7.7	23	3.9
13	7.2	24	3.7
14	6.7	25	3.5
15	6.3		

For SI: 1 foot = 304.8 mm, 1 Btu/H^2 ×°F = 0.0057 kW/m^2 × K.

1406.2.2 Architectural trim. In buildings of Type I, II, III and IV construction that do not exceed three stories or 40 feet (12 192 mm) in height above grade plane, exterior wall coverings shall be permitted to be constructed of wood where permitted by Section 1405.4 or other equivalent combustible material. Combustible exterior wall coverings, other than fire-retardant-treated wood complying with Section 2303.2 for exterior installation, shall not exceed 10 percent of an exterior wall surface area where the fire separation distance is 5 feet (1524 mm) or less. Architectural trim that exceeds 40 feet (12 192 mm) in height above grade plane shall be constructed of approved noncombustible materials and shall be secured to the wall with metal or other approved noncombustible brackets.

1406.2.3 Location. Where combustible exterior wall covering is located along the top of exterior walls, such trim shall be completely backed up by the exterior wall and shall not extend over or above the top of exterior walls.

1406.2.4 Fireblocking. Where the combustible exterior wall covering is furred from the wall and forms a solid surface, the distance between the back of the covering and the wall shall not exceed 1.625 inches (41 mm) and the space thereby created shall be fireblocked in accordance with Section 717.

1406.3 Balconies and similar projections. Balconies and similar projections of combustible construction other than fire-retardant-treated wood shall be fire-resistance rated in accordance with Table 601 for floor construction or shall be of Type IV construction in accordance with Section 602.4. The aggregate length shall not exceed 50 percent of the building's perimeter on each floor.

Exceptions:

1. On buildings of Type I and II construction, three stories or less in height, fire-retardant-treated wood shall be permitted for balconies, porches, decks and exterior stairways not used as required exits.
2. Untreated wood is permitted for pickets and rails or similar guardrail devices that are limited to 42 inches (1067 mm) in height.
3. Balconies and similar projections on buildings of Type III, IV and V construction shall be permitted to be of Type V construction, and shall not be required to have a fire-resistance rating where sprinkler protection is extended to these areas.
4. Where sprinkler protection is extended to the balcony areas, the aggregate length of the balcony on each floor shall not be limited.

1406.4 Bay windows and oriel windows. Bay and oriel windows shall conform to the type of construction required for the building to which they are attached.

Exception: Fire-retardant-treated wood shall be permitted on buildings three stories or less of Type I, II, III and IV construction.

SECTION 1407
METAL COMPOSITE MATERIALS (MCM)

1407.1 General. The provisions of this section shall govern the materials, construction and quality of metal composite materials (MCM) for use as exterior wall coverings in addition to other applicable requirements of Chapters 14 and 16.

1407.1.1 Plastic core. The plastic core of the MCM shall not contain foam plastic insulation as defined in Section 2602.1.

1407.2 Exterior wall finish. MCM used as exterior wall finish or as elements of balconies and similar projections and bay and oriel windows to provide cladding or weather resistance shall comply with Sections 1407.4 through 1407.13.

1407.3 Architectural trim and embellishments. MCM used as architectural trim or embellishments shall comply with Sections 1407.7 through 1407.13.

1407.4 Structural design. MCM systems shall be designed and constructed to resist wind loads as required by Chapter 16 for components and cladding.

1407.5 Approval. Results of approved tests or an engineering analysis shall be submitted to the building official to verify compliance with the requirements of Chapter 16 for wind loads.

1407.6 Weather resistance. MCM systems shall comply with Section 1403 and shall be designed and constructed to resist wind and rain in accordance with this section and the manufacturer's installation instructions.

1407.7 Durability. MCM systems shall be constructed of approved materials that maintain the performance characteristics required in Section 1407 for the duration of use.

1407.8 Fire-resistance rating. Where MCM systems are used on exterior walls required to have a fire-resistance rating in accordance with Section 704, evidence shall be submitted to the building official that the required fire-resistance rating is maintained.

1407.9 Surface-burning characteristics. Unless otherwise specified, MCM shall have a flame spread index of 75 or less and a smoke-developed index of 450 or less when tested as an assembly in the maximum thickness intended for use in accordance with ASTM E 84.

1407.10 Type I, II, III and IV construction. Where installed on buildings of Type I, II, III and IV construction, MCM systems shall comply with Sections 1407.10.1 through 1407.10.4, or 1407.11.

1407.10.1 Surface-burning characteristics. MCM shall have a flame spread index of not more than 25 and a smoke-developed index of not more than 450 when tested as an assembly in the maximum thickness intended for use in accordance with ASTM E 84.

1407.10.2 Thermal barriers. MCM shall be separated from the interior of a building by an approved thermal barrier consisting of 0.5-inch (12.7 mm) gypsum wallboard or equivalent thermal barrier material that will limit the average temperature rise of the unexposed surface to not more than 250°F (121°C) after 15 minutes of fire exposure in accordance with the standard time-temperature curve of ASTM E 119. The thermal barrier shall be installed in such a manner that it will remain in place for not less than 15 minutes based on a test conducted in accordance with UL 1715.

1407.10.3 Thermal barrier not required. The thermal barrier specified for MCM in Section 1407.10.2 is not required where:

1. The MCM system is specifically approved based on tests conducted in accordance with UL 1040 or UL 1715. Such testing shall be performed with the MCM in the maximum thickness intended for use. The MCM system shall include seams, joints and other typical details used in the installation and shall be tested in the manner intended for use.
2. The MCM is used as elements of balconies and similar projections, architectural trim or embellishments.

1407.10.4 Full-scale tests. The MCM exterior wall assembly shall be tested in accordance with, and comply with, the acceptance criteria of NFPA 285. Such testing shall be performed on the MCM system with the MCM in the maximum thickness intended for use.

1407.11 Alternate conditions. MCM and MCM systems shall not be required to comply with Sections 1407.10.1 through 1407.10.4 provided such systems comply with Section 1407.11.1 or 1407.11.2.

1407.11.1 Installations up to 40 feet in height. MCM shall not be installed more than 40 feet (12 190 mm) in height above the grade plane where installed in accordance with Sections 1407.11.1.1 and 1407.11.1.2.

1407.11.1.1 Fire separation distance of 5 feet or less. Where the fire separation distance is 5 feet (1524 mm) or less, the area of MCM shall not exceed 10 percent of the exterior wall surface.

1407.11.1.2 Fire separation distance greater than 5 feet. Where the fire separation distance is greater than 5 feet (1524 mm), there shall be no limit on the area of exterior wall surface coverage using MCM.

1407.11.2 Installations up to 50 feet in height. MCM shall not be installed more than 50 feet (15 240 mm) in height above the grade plane where installed in accordance with Sections 1407.11.2.1 and 1407.11.2.2.

1407.11.2.1 Self ignition temperature. MCM shall have a self-ignition temperature of 650°F (343°C) or greater when tested in accordance with ASTM D 1929.

1407.11.2.2 Limitations. Sections of MCM shall not exceed 300 square feet (27.9 m^2) in area and shall be separated by a minimum of 4 feet (1219 mm) vertically.

1407.12 Type V construction. MCM shall be permitted to be installed on buildings of Type V construction.

1407.13 Labeling. MCM shall be labeled in accordance with Section 1703.5.

SECTION 1408 HIGH-VELOCITY HURRICANE ZONE OTHER MATERIALS

1408.1 Wood.

1408.1.1 Wood and wood products used for wall claddings shall comply with Section 2314 through 2330.

1408.1.2 Wood and wood-products used for wall cladding as non-structural exterior trim, fascia and soffits on buildings of Type I, II-A and IV. Construction may be applied to the outside of exterior walls, cornices, architectural appendages, eaves overhangs and similar projections.

Where an exterior wall is required to be fire resistive, such material shall be separated from the interior of the building by the vertical extension of the exterior wall.

1408.2 Asphalt shingles. Asphalt shingles shall be applied only to solid wood sheathing and shall be in tin-capped and spot-stuck, as set forth in Sections 1512 through 1525.

1408.3 Roll slate or felt. Roll slate or felt shall be applied only to solid wood sheathing and shall be secured by nailing, as set forth in Chapter 15, High-Velocity Hurricane Zones.

1408.4 Metal shingles. Metal shingles shall be applied only to solid wood sheathing and shall be secured as set forth in Chapter 15 (High-Velocity Hurricane Zone).

1408.5 Steel shingles. Steel Siding shall be designed and applied as set forth in Sections 2214 through 2224.

1408.6 Aluminum siding. Aluminum siding shall be designed and applied as set forth in Section 2003.

1408.7 Veneers. Masonry veneers shall be applied as set forth in Sections 2118 through 2122.

1408.8 Combustible materials. Combustible materials and fire resistive characteristics of all materials shall comply with the requirements for the group of occupancy or type of construction, and the required interior finish rating.

1408.9 Other materials. Any cladding materials or assembly not addressed in this code shall be classified by the building official as the one it most nearly resembles, and shall comply with the requirements for loading and fire resistance herein required for such materials and assemblies.

CHAPTER 15

ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

SECTION 1501 GENERAL

1501.1 Scope. The provisions of this chapter shall govern the design, materials, construction and quality of roof assemblies, and rooftop structures.

Exception: Buildings and structures located within the high-velocity hurricane zone shall comply with the provisions of Section 1503.6 and Sections 1512 through 1525.

SECTION 1502 DEFINITIONS

1502.1 General. The following words and terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meanings shown herein.

BUILT-UP ROOF COVERING. Two or more layers of felt cemented together and surfaced with a cap sheet, mineral aggregate, smooth coating or similar surfacing material.

INTERLAYMENT. A layer of felt or nonbituminous saturated felt not less than 18 inches (457 mm) wide, shingled between each course of a wood-shake roof covering.

MECHANICAL EQUIPMENT SCREEN. A partially enclosed rooftop structure used to aesthetically conceal heating, ventilating and air conditioning (HVAC) electrical or mechanical equipment from view.

METAL ROOF PANEL. An interlocking metal sheet having a minimum installed weather exposure of 3 square feet (0.279 m^2) per sheet.

METAL ROOF SHINGLE. An interlocking metal sheet having an installed weather exposure less than 3 square feet (0.279 m^2) per sheet.

MODIFIED BITUMEN ROOF COVERING. One or more layers of polymer-modified asphalt sheets. The sheet materials shall be fully adhered or mechanically attached to the substrate or held in place with an approved ballast layer.

PENTHOUSE. An enclosed, unoccupied structure above the roof of a building, other than a tank, tower, spire, dome cupola or bulkhead, occupying not more than one-third of the roof area.

POSITIVE ROOF DRAINAGE. The drainage condition in which consideration has been made for all loading deflections of the roof deck, and additional slope has been provided to ensure drainage of the roof within 48 hours of precipitation.

REROOFING. The process of recovering or replacing an existing roof covering. See "Roof recover" and "Roof replacement."

ROOF ASSEMBLY. A system designed to provide weather protection and resistance to design loads. The system consists of a roof covering and roof deck or a single component serving as both the roof covering and the roof deck. A roof assembly includes the roof deck, vapor retarder, substrate or thermal barrier, insulation, vapor retarder and roof covering.

ROOF COVERING. The covering applied to the roof deck for weather resistance, fire classification or appearance.

ROOF COVERING SYSTEM. See "Roof assembly."

ROOF DECK. The flat or sloped surface not including its supporting members or vertical supports.

ROOF RECOVER. The process of installing an additional roof covering over a prepared existing roof covering without removing the existing roof covering.

ROOF REPAIR. Reconstruction or renewal of any part of an existing roof for the purposes of its maintenance.

ROOF REPLACEMENT. The process of removing the existing roof covering, repairing any damaged substrate and installing a new roof covering.

ROOF SECTION. A separation or division of a roof area by existing joints, parapet walls, flashing (excluding valleys), difference of elevation (excluding hips and ridges), roof type or legal description; not including the roof area required for a proper tie-off with an existing system.

ROOF VENTILATION. The natural or mechanical process of supplying conditioned or unconditioned air to, or removing such air from, attics, cathedral ceilings or other enclosed spaces over which a roof assembly is installed.

ROOFTOP STRUCTURE. An enclosed structure on or above the roof of any part of a building.

SCUPPER. An opening in a wall or parapet that allows water to drain from a roof.

SINGLE-PLY MEMBRANE. A roofing membrane that is field applied using one layer of membrane material (either homogeneous or composite) rather than multiple layers.

UNDERLAYMENT. One or more layers of felt, sheathing paper, nonbituminous saturated felt or other approved material over which a steep-slope roof covering is applied.

SECTION 1503 WEATHER PROTECTION

1503.1 General. Roof decks shall be covered with approved roof coverings secured to the building or structure in accordance with the provisions of this chapter. Roof coverings shall be designed, installed and maintained in accordance with this code and the approved manufacturer's instructions such that the roof covering shall serve to protect the building or structure.

1503.2 Flashing. Flashing shall be installed in such a manner so as to prevent moisture entering the wall and roof through joints in copings, through moisture-permeable materials and at intersections with parapet walls and other penetrations through the roof plane.

1503.2.1 Locations. Flashing shall be installed at wall and roof intersections, at gutters, wherever there is a change in roof slope or direction, and around roof openings.

Exception: Flashing is not required at hip and ridge junctions.

Where flashing is of metal, the metal shall be corrosion resistant with a thickness not less than provided in Table 1503.2.

TABLE 1503.2
METAL FLASHING MATERIAL

MATERIAL	MINIMUM THICKNESS (INCHES)	GAGE	WEIGHT (LBS PER SQ FT)
Copper			1 (16 oz)
Aluminum	0.024		
Stainless Steel		28	
Galvanized Steel	0.0179	26 (zinc coated G90)	
Aluminum Zinc Coated Steel	0.0179	26 (AZ50 Alum Zinc)	
Zinc Alloy	0.027		
Lead			2.5 (40 oz)
Painted Terne	----		1.25 (20 oz)

1503.3 Coping. Parapet walls shall be properly coped or sealed with noncombustible, weatherproof materials of a width no less than the thickness of the parapet wall. Metal coping shall comply with ANSI/SPRI ES-1 or RAS 111.

1503.4 Roof drainage. Unless roofs are sloped to drain over roof edges, design and installation of roof drainage systems shall comply with the *Florida Building Code, Plumbing* Chapter 11.

1503.4.1 Gutters. Gutters and leaders placed on the outside of buildings, other than Group R-3, private garages and buildings of Type V construction, shall be of noncombustible material or a minimum of Schedule 40 plastic pipe.

1503.4.2 Scupper. Where required for roof drainage, a scupper shall be placed level with the roof surface in a wall or parapet. The scupper shall be located as determined by the slope and the contributing area of the roof. The exterior facing or lining of a scupper, if metal, shall be the same as flashing material required by Sections 1503 through 1510 for the particular type of covering specified for the building. For other type materials, follow manufacturer's specifications.

1503.4.3 Overflow scuppers. When other means of drainage of overflow water is not provided, overflow scuppers shall be placed in walls or parapets not less than 2 inches (51 mm) nor more than 4 inches (102 mm) above the finished roof covering and shall be located as close as practical to required vertical leaders or downspouts or wall and parapet scuppers. An overflow scupper shall be sized in accordance with the *Florida Building Code, Plumbing*.

1503.5 Roof ventilation. Attic ventilation shall be provided in accordance with Section 1203.2 and the manufacturer's installation instructions.

1503.6 Protection against decay and termites. Condensate lines and roof downspouts shall discharge at least 1 foot (305 mm) away from the structure sidewall, whether by underground piping, tail extensions, or splash blocks. Gutters with downspouts are required on all buildings with eaves of less than 6 inches (152 mm) horizontal projection except for gable end rakes or on a roof above another roof.

SECTION 1504
PERFORMANCE REQUIREMENTS

1504.1 Wind resistance of roofs. Roof decks and roof coverings shall be designed for wind loads in accordance with Chapter 16 and Sections 1504.2, 1504.3 and 1504.4.

1504.1.1 Wind resistance of asphalt shingles. Asphalt shingles shall be designed for wind speeds in accordance with Section 1507.2.10.

1504.1.2 Alternative test method. Testing the acceptability of special fastening methods using the methodology in this section is permitted. The wind-induced uplift force on the shingle shall be determined using the method in UL 2390. The resistance of the shingle to the uplift force shall be determined using ASTM D 6381. Shingles passing this test shall be considered suitable for roofs located where the basic wind speed per Figure 1609 is as given in Table 1504.1.2.

Classification requires that the resistance of the shingle to wind uplift, measured using the method in ASTM D 6381, exceed the calculated load imposed by wind in the applicable zone as determined using UL 2390.

Classification by this method applies to buildings less than 60 feet (18 288 mm) high and with Wind Exposures B and C only in an Occupancy Category of I or II. Wrappers of shingle bundles that have been qualified using this alternative method shall be labeled with the tested wind classification and reference UL 2390/ASTM D 6381.

TABLE 1504.1.2
ROOF COVERING CLASSIFICATION USING ALTERNATIVE METHOD

MAXIMUM BASIC WIND SPEED (mph)	ASTM D 6381 CLASSIFICATION
90	Class D
120	Class G
150	Class H

For SI: 1 mile per hour = 0.447m/s.

1504.2 Wind resistance of clay and concrete tile. Clay and concrete tile roof coverings shall be connected to the roof deck in accordance with Chapter 16.

1504.3 Wind resistance of nonballasted roofs. Roof coverings installed on roofs in accordance with Section 1507 that are mechanically attached or adhered to the roof deck shall be designed to resist the design wind load pressures for cladding in Chapter 16.

1504.3.1 Other roof systems. Roof systems with built-up, modified bitumen, fully adhered or mechanically attached single-ply through fastened metal panel roof systems, and other types of membrane roof coverings shall also be tested in accordance with FM 4450, FM 4470, UL 580 or UL 1897.

1504.3.2 Metal panel roof systems. Metal panel roof systems through fastened or standing seam shall be tested in accordance with UL 580 or ASTM E 1592 or TAS 125.

Exception: Metal roofs constructed of cold-formed steel, where the roof deck acts as the roof covering and provides both weather protection and support for structural loads, shall be permitted to be designed and tested in accordance with the applicable referenced structural design standard in Section 2209.1.

1504.4 Ballasted low-slope roof systems. Ballasted low-slope (roof slope < 2:12) single-ply roof system coverings shall be designed ANSI/SPRI RP-4.

1504.5 Edge securement for low-slope roofs. Low-slope membrane roof systems metal edge securement, except gutters, shall be designed and installed for wind loads in accordance with Chapter 16 and tested for resistance in accordance with ANSI/SPRI ES-1 or RAS 111 except the basic wind speed shall be determined from Figure 1609.

1504.6 Physical properties. Roof coverings installed on low-slope roofs (roof slope < 2:12) in accordance with Section 1507 shall demonstrate physical integrity over the working life of the roof based upon 2,000 hours of exposure to accelerated weathering tests conducted in accordance with ASTM G 152, ASTM G 153, ASTM G 155 or ASTM G 154. Those roof coverings that are subject to cyclical flexural response due to wind loads shall not demonstrate any significant loss of tensile strength for unreinforced membranes or breaking strength for reinforced membranes when tested as herein required.

1504.7 Impact resistance. Roof coverings installed on low-slope roofs (roof slope < 2:12) in accordance with Section 1507 shall resist impact damage based on the results of tests conducted in accordance with ASTM D 3746, ASTM D 4272, CGSB 37-GP-52M or the "Resistance to Foot Traffic Test" in Section 5.5 of FM 4470. All structural metal roofing systems having a thickness equal to or greater than 22 gage and all nonstructural metal roof systems having a thickness equal to or greater than 26 gage shall be exempt from the tests listed above.

1504.8 Gravel and stone. Gravel or stone shall not be used on the roof of a building located in a hurricane-prone region as defined in Section 1609.2, or on any other building with a mean roof height exceeding that permitted by Table 1504.8 based on the exposure category and basic wind speed at the building site.

TABLE 1504.8
MAXIMUM ALLOWABLE MEAN ROOF HEIGHT PERMITTED FOR BUILDINGS WITH GRAVEL OR STONE ON THE ROOF IN AREAS OUTSIDE A HURRICANE-PRONE REGION

BASIC WIND SPEED FROM FIGURE 1609 (mph)[b]	MAXIMUM MEAN ROOF HEIGHT (ft)[a,c]		
	Exposure category		
	B	C	D
85	170	60	30
90	110	35	15
95	75	20	NP
100	55	15	NP
105	40	NP	NP
110	30	NP	NP
115	20	NP	NP
120	15	NP	NP
Greater than 120	NP	NP	NP

For SI: 1 foot = 304.8 mm; 1 mile per hour = 0.447 m/s.
a. Mean roof height in accordance with Section 1609.2.
b. For intermediate values of basic wind speed, the height associated with the next higher value of wind speed shall be used, or direct interpolation is permitted.
c. NP = gravel and stone not permitted for any roof height.

1504.9 Margin of safety. A margin of safety of 2:1 shall be applied to all wind uplift resistance test results except when a margin of safety is specified in the test standard.

Exception: Asphalt shingles testing resulting in a miles per hour rating as required in Section 1507.2.10.

SECTION 1505
FIRE CLASSIFICATION

1505.1 General. Roof assemblies shall be divided into the classes defined below. Class A, B and C roof assemblies and roof coverings required to be listed by this section shall be tested in accordance with ASTM E 108 or UL 790. In addition, fire-retardant-treated wood roof coverings shall be tested in accordance with ASTM D 2898. The minimum roof coverings installed on buildings shall comply with Table 1505.1 based on the type of construction of the building.

Exception: Skylights and sloped glazing that comply with Chapter 24 or Section 2610.

TABLE 1505.1[a,b]
MINIMUM ROOF COVERING CLASSIFICATION FOR TYPES OF CONSTRUCTION

IA	IB	IIA	IIB	IIIA	IIIB	IV	VA	VB
B	B	B	C[c]	B	C[c]	B	B	C[c]

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2.

a. Unless otherwise required in accordance with the *International* Wildland-Urban Interface Code or due to the location of the building within a fire district in accordance with Appendix D.

b. Nonclassified roof coverings shall be permitted on buildings of Group R-3 and Group U occupancies, where there is a minimum fire-separation distance of 6 feet measured from the leading edge of the roof.

c. Buildings that are not more than two stories in height and having not more than 6,000 square feet of projected roof area and where there is a minimum 10-foot fire-separation distance from the leading edge of the roof to a lot line on all sides of the building, except for street fronts or public ways, shall be permitted to have roofs of No. 1 cedar or redwood shakes and No. 1 shingles.

1505.2 Class A roof assemblies. Class A roof assemblies are those that are effective against severe fire test exposure. Class A roof assemblies and roof coverings shall be listed and identified as Class A by an approved testing agency. Class A roof assemblies shall be permitted for use in buildings or structures of all types of construction.

> **Exception:** Class A roof assemblies include those with coverings of brick, masonry, slate, clay or concrete roof tile, exposed concrete roof deck, ferrous or copper shingles or panels.

1505.3 Class B roof assemblies. Class B roof assemblies are those that are effective against moderate fire-test exposure. Class B roof assemblies and roof coverings shall be listed and identified as Class B by an approved testing agency.

> **Exception:** Class B roof assemblies include those with coverings of metal sheets and shingles.

1505.4 Class C roof assemblies. Class C roof assemblies are those that are effective against light fire-test exposure. Class C roof assemblies and roof coverings shall be listed and identified as Class C by an approved testing agency.

1505.5 Nonclassified roofing. Nonclassified roofing is approved material that is not listed as a Class A, B or C roof covering.

1505.6 Fire-retardant-treated wood shingles and shakes. Fire-retardant-treated wood shakes and shingles shall be treated by impregnation with chemicals by the full-cell vacuum-pressure process, in accordance with AWPA C1. Each bundle shall be marked to identify the manufactured unit and the manufacturer, and shall also be labeled to identify the classification of the material in accordance with the testing required in Section 1505.1, the treating company and the quality control agency.

1505.7 Special purpose roofs. Reserved.

SECTION 1506
MATERIALS

1506.1 Scope. The requirements set forth in this section shall apply to the application of roof-covering materials specified herein. Roof coverings shall be applied in accordance with this chapter and the manufacturer's installation instructions. Installation of roof coverings shall comply with the applicable provisions of Section 1507.

1506.2 Compatibility of materials. Roofs and roof coverings shall be of materials that are compatible with each other and with the building or structure to which the materials are applied.

1506.3 Material specifications and physical characteristics. Roof-covering materials shall conform to the applicable standards listed in this chapter. In the absence of applicable standards or where materials are of questionable suitability, testing by an approved agency shall be required by the building official to determine the character, quality and limitations of application of the materials.

1506.4 Product identification. Roof-covering materials shall be delivered in packages bearing the manufacturer's identifying marks and approved testing agency labels required in accordance with Section 1505. Bulk shipments of materials shall be accompanied with the same information issued in the form of a certificate or on a bill of lading by the manufacturer.

1506.5 Nails. Nails shall be corrosion resistant nails conforming to ASTM F 1667. The corrosion resistance shall meet ASTM A 641, Class 1 or an equal corrosion resistance by coating, electro galvanization, mechanical galvanization, hot dipped galvanization, stainless steel, nonferrous metal and alloys or other suitable corrosion resistant material.

1506.6 Screws. Wood screws shall conform to ANSI/ASME B 18.6.1. Screws shall be corrosion resistant by coating, galvanization, stainless steel, nonferrous metal or other suitable corrosion-resistant material. The corrosion resistance shall be demonstrated through one of the following methods:

1. Corrosion resistance equivalent to ASTM A 641, Class 1, or
2. Corrosion resistance in accordance with TAS 114, Appendix E, or
3. Corrosion resistant coating exhibiting not more than 5 percent red rust after 1,000 hours exposure in accordance with ASTM B 117.

1506.7 Clips. Clips shall be corrosion resistant clips. The corrosion resistance shall meet 0.90 oz per sq ft (0.458 kg/m^2) measured according to ASTM A 90/A 90M, TAS 114 Appendix E or an equal corrosion resistance coating, electro galvanization, mechanical galvanization, hot dipped galvanization, stainless steel, nonferrous metals and alloys or other suitable corrosion resistant material. Stainless steel clips shall conform to ASTM A 167, Type 304.

SECTION 1507
REQUIREMENTS FOR ROOF COVERINGS

1507.1 Scope. Roof coverings shall be applied in accordance with the applicable provisions of this section and the manufacturer's installation instructions.

1507.2 Asphalt shingles. The installation of asphalt shingles shall comply with the provisions of this section.

> **1507.2.1 Deck requirements.** Asphalt shingles shall be fastened to solidly sheathed decks.

1507.2.2 Slope. Asphalt shingles shall only be used on roof slopes of two units vertical in 12 units horizontal (17-percent slope) or greater. For roof slopes from two units vertical in 12 units horizontal (17-percent slope) up to four units vertical in 12 units horizontal (33-percent slope), double underlayment application is required in accordance with Section 1507.2.8.

1507.2.3 Underlayment. Unless otherwise noted, required underlayment shall conform to ASTM D 226, Type I or Type II, or ASTM D 4869 Type I or Type II.

1507.2.4 Self-adhering polymer modified bitumen sheet. Self-adhering polymer modified bitumen sheet shall comply with ASTM D 1970.

1507.2.5 Asphalt shingles. Asphalt shingles shall have self-seal strips or be interlocking and comply with ASTM D 225 or ASTM D 3462. Shingles shall also comply with Table 1507.2.10. Asphalt shingle packaging shall bear labeling indicating compliance with ASTM D 3161 or a listing by an approved testing agency in accordance with the requirements of Section 1609.5.2.

1507.2.6 Fasteners. Fasteners for asphalt shingles shall be galvanized, stainless steel, aluminum or copper roofing nails, minimum 12 gage [0.105 inch (2.67 mm)] shank with a minimum 0.375 inch-diameter (9.5 mm) head, of a length to penetrate through the roofing materials and a minimum of 0.75 inch (19.1 mm) into the roof sheathing. Where the roof sheathing is less than 0.75 inch (19.1 mm) thick, the nails shall penetrate through the sheathing. Fasteners shall comply with ASTM F 1667.

1507.2.6.1 The nail component of plastic cap nails shall meet the corrosion resistance requirements of 1507.2.6.

1507.2.7 Attachment. Asphalt shingles shall have the minimum number of fasteners required by the manufacturer and Section 1504.1. Asphalt shingles shall be secured to the roof with not less than four fasteners per strip shingle or two fasteners per individual shingle. Where the roof slope exceeds 21 units vertical in 12 units horizontal (21:12), asphalt shingles shall be installed in accordance with the manufacturer's printed installation instructions for steep-slope roof applications.

1507.2.8 Underlayment application. For roof slopes from two units vertical in 12 units horizontal (17-percent slope) and up to four units vertical in 12 units horizontal (33-percent slope), underlayment shall be two layers applied in the following manner. Apply a minimum 19-inch-wide (483 mm) strip of underlayment felt parallel with and starting at the eaves, fastened sufficiently to hold in place. Starting at the eave, apply 36-inch-wide (914 mm) sheets of underlayment overlapping successive sheets 19 inches (483 mm), by fastened sufficiently to hold in place. Distortions in the underlayment shall not interfere with the ability of the shingles to seal. For roof slopes of four units vertical in 12 units horizontal (33-percent slope) or greater, underlayment shall be one layer applied in the following manner. Underlayment shall be applied shingle fashion, parallel to and starting from the eave and lapped 2 inches (51 mm), fastened sufficiently to hold in place. Distortions in the underlayment shall not interfere with the ability of the shingles to seal.

1507.2.8.1 High wind attachment. Underlayment applied in areas subject to high winds (greater than 110 mph in accordance with Figure 1609) shall be applied with corrosion- resistant fasteners in accordance with the manufacturer's instructions. Fasteners are to be applied along the overlap at a maximum spacing of 36 inches (914 mm) on center.

1507.2.8.2 Ice dam membrane. Reserved.

1507.2.9 Flashings. Flashing for asphalt shingles shall comply with this section. Flashing shall be applied in accordance with this section and the asphalt shingle manufacturer's printed instructions.

1507.2.9.1 Base and counter flashing. Base and counter flashing shall be installed as follows:

1. In accordance with manufacturer's installation instructions, or
2. A continuous metal "L" flashing shall be set in approved flashing cement and set flush to base of wall and over the underlayment. Both horizontal and vertical metal flanges shall be fastened 6 inches (152 mm) on center with approved fasteners. All laps shall be a minimum of 4 inches (102 mm) fully sealed in approved flashing cement. Flashing shall start at the lower portion of roof to insure water-shedding capabilities of all metal laps. The entire edge of the horizontal flange shall be sealed covering all nail penetrations with approved flashing cement and membrane. Shingles will overlap the horizontal flange and shall be set in approved flashing cement.

Base flashing shall be of either corrosion resistant metal with a minimum thickness provided in Table 1503.2 or mineral surface roll roofing weighing a minimum of 77 pounds per 100 square feet (3.76 kg/m^2). Counter flashing shall be corrosion resistant metal with a minimum thickness provided in Table 1503.2.

1507.2.9.2 Valleys. Valley linings shall be installed in accordance with the manufacturer's instructions before applying shingles. Valley linings of the following types shall be permitted:

1. For open valleys lined with metal, the valley lining shall be at least 16 inches (406 mm) wide and of any of the corrosion-resistant metals in Table 1503.2.
2. For open valleys, valley lining of two plies of mineral-surfaced roll roofing complying with ASTM D 6380 Class M or ASTM D 3909 shall be permitted. The bottom layer shall be 18 inches (457 mm) and the top layer a minimum of 36 inches (914 mm) wide.
3. For closed valleys, valley lining of one ply of smooth roll roofing complying with ASTM D 6380 Class S and at least 36 inches (914 mm) wide or types as described in Items 1 or 2 above shall be

permitted. Specialty underlayment complying with ASTM D 1970 may be used in lieu of the lining material.

Table 1507.2.9.2 Valley Lining Material. Reserved.

1507.2.9.3 Drip edge. Provide drip edge at eaves and gables of shingle roofs. Overlap to be a minimum of 2 inches (51 mm). Eave drip edges shall extend ½ inch (13 mm) below sheathing and extend back on the roof a minimum of 2 inches (51 mm). Drip edge at eaves shall be permitted to be installed either over or under the underlayment. If installed over the underlayment, there shall be a minimum 4 inches (51 mm) width of roof cement installed over the drip edge flange. Drip edge shall be mechanically fastened a maximum of 12 inches (305 mm) on center. Where the basic wind speed per Figure 1609 is 110 mph (177 km/h) or greater or the mean roof height exceeds 33 feet (10 058 mm), drip edges shall be mechanically fastened a maximum of 4 inches (102 mm) on center.

1507.2.9.4 Crickets or saddles. A cricket or saddle shall be installed on the ridge side of any chimney or penetration greater than 30 inches (762 mm) wide as measured perpendicular to the slope. Cricket or saddle coverings shall be sheet metal or of the same material as the roof covering.

Exception: Any penetration that allows water to flow around it shall not require a cricket or saddle.

1507.2.10 Wind Resistance of Asphalt Shingles. Asphalt Shingles shall be classified in accordance with ASTM D3161, TAS 107 or ASTM D7158 to resist the basic wind speed per Figure 1609. Shingles classified as ASTM D 3161 Class D or ASTM D 7158 Class G are acceptable for use in the 100-mph wind zone. Shingles classified as ASTM D3161 Class F, TAS107 or ASTM D 7158 Class H are acceptable for use in all wind zones. Asphalt shingle wrappers shall indicate compliance with one of the required classifications as shown in Table 1507.2.10.

TABLE 1507.2.10
WIND RESISTANCE OF ASPHALT SHINGLES

MAXIMUM BASIC WIND SPEED MPH (per Figure 1609)	CLASSIFICATION
100	ASTM D 3161 Class D or ASTM D 7158 Class G or TAS 107
110	ASTM D 3161 Class F or ASTM D 7158 Class G or TAS 107
120	ASTM D 3161 Class F or ASTM D 7158 Class G or TAS 107
130	ASTM D 3161 Class F or ASTM D 7158 Class H or TAS 107
140	ASTM D 3161 Class F or ASTM D 7158 Class H or TAS 107
150	ASTM D 3161 Class F or ASTM D 7158 Class H or TAS 107

1507.3 Clay and concrete tile. The installation of clay and concrete tile shall comply with the provisions of this section.

1507.3.1 Deck requirements. Concrete and clay tile shall be installed only over solid sheathing except where the roof covering is specifically designed and tested in accordance with Section 1609.5.2 to be applied over structural spaced sheathing boards.

1507.3.2 Deck slope. Clay and concrete roof tile shall be installed in accordance with the recommendations of FRSA/RTI 07320.

1507.3.3 Underlayment. Unless otherwise noted, required underlayment shall conform to: ASTM D 226, Type II; ASTM D 2626; ASTM D 1970 or ASTM D 6380 mineral-surfaced roll roofing. Underlayment shall be applied according to the tile manufacturer's installation instructions or the recommendations of the FRSA/TRI 07320.

1507.3.3.1 Slope and underlayment requirements. Refer to FRSA/TRI manual for underlayment and slope requirements for specific roof tile systems.

1507.3.3.2 High-slope roofs. Reserved.

1507.3.4 Clay tile. Clay roof tile shall comply with ASTM C 1167.

1507.3.5 Concrete tile. Concrete roof tile shall comply with ASTM C 1492.

1507.3.6 Fasteners. Tile fasteners shall be corrosion resistant and not less than 11 gage, $^5/_{16}$-inch (8.0 mm) head, and of sufficient length to penetrate the deck a minimum of 0.75 inch (19.1 mm) or through the thickness of the deck, whichever is less or in accordance with the FRSA/TRI 07320 manual. Attaching wire for clay or concrete tile shall not be smaller than 0.083 inch (2.1 mm).

1507.3.7 Attachment. Clay and concrete roof tiles shall be fastened in accordance with Section 1609 or in accordance with FRSA/TRI 07320 Installation Manual.

1507.3.8 Application. Tile shall be applied according to the manufacturer's installation instructions or recommendations of the FRSA/TRI 07320.

1507.3.9 Flashing. At the juncture of the roof vertical surfaces, flashing and counterflashing shall be provided in accordance with the manufacturer's installation instructions or the recommendations of the FRSA/TRI 07320 Manual.

1507.4 Metal roof panels. The installation of metal roof panels shall comply with the provisions of this section.

1507.4.1 Deck requirements. Metal roof panel roof coverings shall be applied to a solid or closely fitted deck, except where the roof covering is specifically designed to be applied to spaced supports.

1507.4.2 Deck slope. Minimum slopes for metal roof panels shall comply with the following:

1. The minimum slope for lapped, nonsoldered seam metal roofs without applied lap sealant shall be three units vertical in 12 units horizontal (25-percent slope).

2. The minimum slope for lapped, nonsoldered seam metal roofs with applied lap sealant shall be one-half unit vertical in 12 units horizontal (4-percent slope). Lap sealants shall be applied in accordance with the approved manufacturer's installation instructions.
3. The minimum slope for standing seam of roof systems shall be one-quarter unit vertical in 12 units horizontal (2-percent slope).

1507.4.3 Material standards. Metal-sheet roof covering systems that incorporate supporting structural members shall be designed in accordance with Chapter 22. Metal-sheet roof coverings installed over structural decking shall comply with Table 1507.4.3(1). The materials used for metal-sheet roof coverings shall be naturally corrosion resistant or provided with corrosion resistance in accordance with the standards and minimum thicknesses shown in Table 1507.4.3(2).

TABLE 1507.4.3(2)
MINIMUM CORROSION RESISTANCE

55% Aluminum-Zinc Alloy Coated Steel	ASTM A 792 AZ 50
5% Aluminum Alloy-coated steel	ASTM A875 GF60
Aluminum-coated steel	ASTM A463 T2 65
Galvanized Steel	ASTM A 653 G-90
Prepainted Steel	ASTM A 755[a]

a. Paint systems in accordance with ASTM A 755 shall be applied over steel products with corrosion resistant coatings complying with ASTM A 792, ASTM A 875, ASTM A 463, or ASTM A 653.

1507.4.4 Attachment. Metal roof panels shall be secured to the supports in accordance with the approved manufacturer's fasteners. In the absence of manufacturer recommendations, the following fasteners shall be used:

1. Galvanized fasteners shall be used for steel roofs.
2. 300 series stainless-steel fasteners shall be used for copper roofs.

TABLE 1507.4.3(1)
METAL ROOF COVERINGS

ROOF COVERING TYPE	STANDARD	STANDARD APPLICATION RATE/THICKNESS
Aluminum	ASTM B 209	0.024 inch minimum thickness for roll-formed panels and 0.019 inch minimum thickness for press-formed shingles.
Aluminum-zinc coated steel	ASTM A 792	0.013 inch minimum thickness, AZ 50 (coated minimum application rate)
Cold-rolled copper	ASTM B 370	Minimum 16 oz/sq. ft. and 12 oz./sq. ft. high yield copper for metal-sheet roof covering systems: 12 oz/sq. ft. for preformed metal shingle systems.
Copper	ASTM B 370	16 oz./sq. ft. for metal-sheet roof-covering systems; 12 oz./sq. ft. for preformed metal shingle systems.
Galvanized steel	ASTM A 653	0.013 inch minimum thickness, G-90 zinc-coated[a].
Hard lead		2 lbs./sq. ft.
Lead-coated copper	ASTM B 101	
Prepainted steel	ASTM A 755	
Soft lead		3 lbs./sq. ft.
Stainless steel	ASTM A 240	300 Series Alloys
Steel	ASTM A 924	
Terne and terne-coated stainless		Terne coating of 40 lbs. per double base box, field painted where applicable in accordance with manufacturer's installation instructions.
Zinc		0.027 inch minimum thickness; 99.995% electrolytic high grade zinc with alloy additives of copper (0.08% - 0.20%), titanium (0.07% - 0.12%) and aluminum (0.015%).

For SI: 1 ounce per square foot = 0.0026 kg/m^2,
1 pound per square foot = 4.882 kg/m^2,
1 inch = 25.4 mm, 1 pound = 0.454 kg.

a. For Group U buildings, the minimum coating thickness for ASTM A 653 galvanized steel roofing shall be G-60.

3. Aluminum-zinc coated fasteners are acceptable for aluminum-zinc coated roofs.
4. Stainless-steel fasteners are acceptable for all types of metal roofs.

1507.4.5 Underlayment. Underlayment shall be installed as per manufacturer's installation guidelines.

1507.5 Metal roof shingles. The installation of metal roof shingles shall comply with the provisions of this section.

1507.5.1 Deck requirements. Metal roof shingles shall be applied to a solid or closely fitted deck, except where the roof covering is specifically designed to be applied to spaced sheathing.

1507.5.2 Deck slope. Metal roof shingles shall not be installed on roof slopes below three units vertical in 12 units horizontal (25-percent slope).

1507.5.2.1 Underlayment shall be installed as per manufacturer's installation guidelines.

1507.5.3 Underlayment. Underlayment shall comply with ASTM D 226, Type I or Type II or ASTM D 1970 or ASTM D 4869.

1507.5.4 Material standards. Metal roof shingle roof coverings shall comply with Table 1507.4.3(1). The materials used for metal-roof shingle roof coverings shall be naturally corrosion resistant or provided with corrosion resistance in accordance with the standards and minimum thicknesses specified in the standards listed in Table 1507.4.3(2).

1507.5.5 Attachment. Metal roof shingles shall be secured to the roof in accordance with the approved manufacturer's installation instructions.

1507.5.6 Flashing. Roof valley flashing shall be of corrosion-resistant metal of the same material as the roof covering or shall comply with the standards in Table 1507.4.3. The valley flashing shall extend at least 8 inches (203 mm) from the centerline each way and shall have a splash diverter rib not less than 0.75 inch (19.1 mm) high at the flow line formed as part of the flashing. Sections of flashing shall have an end lap of not less than 4 inches (102 mm).

1507.6 Mineral-surfaced roll roofing. The installation of mineral-surfaced roll roofing shall comply with this section.

1507.6.1 Deck requirements. Mineral-surfaced roll roofing shall be fastened to solidly sheathed roofs.

1507.6.2 Deck slope. Mineral-surfaced roll roofing shall not be applied on roof slopes below one unit vertical in 12 units horizontal (8-percent slope).

1507.6.3 Underlayment. Underlayment shall comply with ASTM D 226, Type I or Type II or ASTM D 1970 or ASTM D 4869.

1507.6.4 Material standards. Mineral-surfaced roll roofing shall conform to ASTM D 6380 Class M or Class WS or ASTM D 3909.

1507.7 Slate shingles. The installation of slate shingles shall comply with the provisions of this section.

1507.7.1 Deck requirements. Slate shingles shall be fastened to solidly sheathed roofs.

1507.7.2 Deck slope. Slate shingles shall only be used on slopes of four units vertical in 12 units horizontal (4:12) or greater.

1507.7.3 Underlayment. Underlayment shall comply with ASTM D 226, Type II or ASTM D 4869.

1507.7.4 Material standards. Slate shingles shall comply with ASTM C 406.

1507.7.5 Application. Minimum headlap for slate shingles shall be in accordance with Table 1507.7.5. Slate shingles shall be secured to the roof with two fasteners per slate.

TABLE 1507.7.5
SLATE SHINGLE HEADLAP

SLOPE	HEADLAP (inches)
4:12 < slope < 8:12	4
8:12 < slope < 20:12	3
slope ≥ 20:12	2

For SI: 1 inch = 25.4 mm.

1507.7.6 Flashing. Flashing and counter flashing shall be made with sheet metal. Valley flashing shall be a minimum of 16 inches (381 mm) wide. Valley and flashing metal shall be a minimum thickness provided in Table 1503.2 nonferrous metal or stainless steel.

1507.8 Wood shingles. The installation of wood shingles shall comply with the provisions of this section and Table 1507.8.

1507.8.1 Deck requirements. Wood shingles shall be installed on solid or spaced sheathing. Where spaced sheathing is used, sheathing boards shall not be less than 1-inch by 4-inch (25 mm by 102 mm) nominal dimensions and shall be spaced on centers equal to the weather exposure to coincide with the placement of fasteners.

1507.8.1.1 Solid sheathing required. Reserved.

1507.8.2 Deck slope. Wood shingles shall be installed on slopes of three units vertical in 12 units horizontal (25-percent slope) or greater.

1507.8.3 Underlayment. Underlayment shall comply with ASTM D 226, Type I or ASTM D 4869.

1507.8.4 Material standards. Wood shingles shall be of naturally durable wood and comply with the requirements of Table 1507.8.4.

TABLE 1507.8.4
WOOD SHINGLE MATERIAL REQUIREMENTS

MATERIAL	APPLICABLE MINIMUM GRADES	GRADING RULES
Wood shingles of naturally durable wood	1, 2 or 3	CSSB

CSSB = Cedar Shake and Shingle Bureau

1507.8.5 Attachment. Fasteners for wood shingles shall be corrosion resistant with a minimum penetration of 0.75 inch (19.1 mm) into the sheathing. For sheathing less than 0.5 inch (12.7 mm) in thickness, the fasteners shall extend through the sheathing. Each shingle shall be attached with a minimum of two fasteners.

TABLE 1507.8
WOOD SHINGLE AND SHAKE INSTALLATION

ROOF ITEM	WOOD SHINGLES	WOOD SHAKES
1. Roof slope	Wood shingles shall be installed on slopes of three units vertical in 12 units horizontal (3:12) or greater.	Wood shakes shall be installed on slopes of four units vertical in 12 units horizontal (4:12) or greater.
2. Deck requirement	—	—
Temperate climate	Shingles shall be applied to roofs with solid or spaced sheathing. Where spaced sheathing is used, sheathing boards shall not be less than 1″ × 4″ nominal dimensions and shall be spaced on center equal to the weather exposure to coincide with the placement of fasteners.	Shakes shall be applied to roofs with solid or spaced sheathing.Where spaced sheathing is used, sheathing boards shall not be less than 1″ × 4″ nominal dimensions and shall be spaced on center equal to the weather exposure to coincide with the placement of fasteners. When 1″ × 4″ spaced sheathing is installed at 10 inches, boards must be installed between the sheathing boards.
3. Interlayment	No requirements.	Interlayment shall comply with ASTM D 226, Type 1.
4. Underlayment	—	—
Temperate climate	Underlayment shall comply with ASTM D 226, Type 1.	Underlayment shall comply with ASTM D 226, Type 1.
5. Application	—	—
Attachment	Fasteners for wood shingles shall be corrosion resistant with a minimum penetration of 0.75 inch into the sheathing. For sheathing less than 0.5 inch thick, the fasteners shall extend through the sheathing.	Fasteners for wood shakes shall be corrosion resistant with a minimum penetration of 0.75 inch into the sheathing. For sheathing less than 0.5 inch thick, the fasteners shall extend through the sheathing.
No. of fasteners	Two per shingle.	Two per shake.
Exposure	Weather exposures shall not exceed those set forth in Table 1507.8.6	Weather exposures shall not exceed those set forth in Table 1507.9.7
Method	Shingles shall be laid with a side lap of not less than 1.5 inches between joints in courses, and no two joints in any three adjacent courses shall be in direct alignment. Spacing between shingles shall be 0.25 to 0.375 inch.	Shakes shall be laid with a side lap of not less than 1.5 inches between joints in adjacent courses. Spacing between shakes shall not be less than 0.375 inch or more than 0.625 inch for shakes and tapersawn shakes of naturally durable wood and shall be 0.25 to 0.375 inch for preservative taper sawn shakes.
Flashing	In accordance with Section 1507.8.7.	In accordance with Section 1507.9.8.

For SI: 1 inch = 25.4 mm, °C = [(°F) - 32]/1.8.

1507.8.6 Application. Wood shingles shall be laid with a side lap not less than 1.5 inches (38 mm) between joints in adjacent courses, and not be in direct alignment in alternate courses. Spacing between shingles shall be 0.25 to 0.375 inches (6.4 to 9.5 mm). Weather exposure for wood shingles shall not exceed that set in Table 1507.8.6.

TABLE 1507.8.6
WOOD SHINGLE WEATHER EXPOSURE AND ROOF SLOPE

ROOFING MATERIAL	LENGTH (inches)	GRADE	EXPOSURE (inches)	
			3:12 pitch to < 4:12	4:12 pitch or steeper
Shingles of naturally durable wood	16	No. 1 No. 2 No. 3	3.75 3.5 3	5 4 3.5
	18	No. 1 No. 2 No. 3	4.25 4 3.5	5.5 4.5 4
	24	No. 1 No. 2 No. 3	5.75 5.5 5	7.5 6.5 5.5

For SI: 1 inch = 25.4 mm.

1507.8.7 Flashing. At the juncture of the roof and vertical surfaces, flashing and counterflashing shall be provided in accordance with the manufacturer's installation instructions, and where of metal, shall not be less than 0.019-inch (0.48 mm) (No. 26 galvanized sheet gage) corrosion-resistant metal. The valley flashing shall extend at least 11 inches (279 mm) from the centerline each way and have a splash diverter rib not less than 1 inch (25 mm) high at the flow line formed as part of the flashing. Sections of flashing shall have an end lap of not less than 4 inches (102 mm). For roof slopes of three units vertical in 12 units horizontal (25-percent slope) and over, the valley flashing shall have a 36-inch-wide (914 mm) underlayment of one layer of Type I underlayment running the full length of the valley, in addition to other required underlayment.

1507.9 Wood shakes. The installation of wood shakes shall comply with the provisions of this section and Table 1507.8.

1507.9.1 Deck requirements. Wood shakes shall only be used on solid or spaced sheathing. Where spaced sheathing is used, sheathing boards shall not be less than 1-inch by 4-inch (25 mm by 102 mm) nominal dimensions and shall be spaced on centers equal to the weather exposure to coincide with the placement of fasteners. Where 1-inch by 4-inch (25 mm by 102 mm) spaced sheathing is installed at 10 inches (254 mm) o.c., additional 1-inch by 4-inch (25 mm by 102 mm) boards shall be installed between the sheathing boards.

1507.9.1.1 Solid sheathing required. Reserved.

1507.9.2 Deck slope. Wood shakes shall only be used on slopes of three units vertical in 12 units horizontal (33-percent slope) or greater.

1507.9.3 Underlayment. Underlayment shall comply with ASTM D 226, Type I or ASTM D 4869.

1507.9.4 Interlayment. Interlayment shall comply with ASTM D 226, Type I.

1507.9.5 Material standards. Wood shakes shall comply with the requirements of Table 1507.9.5.

TABLE 1507.9.5
WOOD SHAKE MATERIAL REQUIREMENTS

MATERIAL	MINIMUM GRADES	APPLICABLE GRADING RULES
Wood shakes of naturally durable wood	1	CSSB
Taper sawn shakes of naturally durable wood	1 or 2	CSSB
Preservative-treated shakes and shingles of naturally durable wood	1	CSSB
Fire-retardant-treated shakes and shingles of naturally durable wood	1	CSSB
Preservative-treated taper sawn shakes of Southern pine treated in accordance with AWPA U1 (Commodity Specification A, Use Category 3B and Section 5.6)	1 or 2	TFS

CSSB = Cedar Shake and Shingle Bureau.
TFS = Forest Products Laboratory of the Texas Forest Services.

1507.9.6 Attachment. Fasteners for wood shakes shall be corrosion resistant with a minimum penetration of 0.75 inch (19.1 mm) into the sheathing. For sheathing less than 0.5 inch (12.7 mm) in thickness, the fasteners shall extend through the sheathing. Each shake shall be attached with a minimum of two fasteners.

1507.9.7 Application. Wood shakes shall be laid with a side lap not less than 1.5 inches (38 mm) between joints in adjacent courses. Spacing between shakes in the same course shall be 0.375 to 0.625 inches (9.5 to 15.9 mm) for shakes and taper sawn shakes of naturally durable wood and shall be 0.25 to 0.375 inch (6.4 to 9.5 mm) for preservative taper sawn shakes. Weather exposure for wood shakes shall not exceed those set in Table 1507.9.7.

TABLE 1507.9.7
WOOD SHAKE WEATHER EXPOSURE AND ROOF SLOPE

ROOFING MATERIAL	LENGTH (inches)	GRADE	EXPOSURE (inches) 4:12 PITCH OR STEEPER
Shakes of naturally durable wood	18 24	No. 1 No. 1	7.5 10[a]
Preservative-treated taper sawn shakes of Southern yellow pine	18 24	No. 1 No. 1	7.5 10
	18 24	No. 2 No. 2	5.5 7.5
Taper sawn shakes of naturally durable wood	18 24	No. 1 No. 1	7.5 10
	18 24	No. 2 No. 2	5.5 7.5

For SI: 1 inch = 25.4 mm.
a. For 24-inch by 0.375-inch handsplit shakes, the maximum exposure is 7.5 inches.

1507.9.8 Flashing. At the juncture of the roof and vertical surfaces, flashing and counterflashing shall be provided in accordance with the manufacturer's installation instructions, and where of metal, shall not be less than 0.019-inch (0.48 mm) (No. 26 galvanized sheet gage) corrosion-resistant metal. The valley flashing shall extend at least 11 inches (279 mm) from the centerline each way and have a splash diverter rib not less than 1 inch (25 mm) high at the flow line formed as part of the flashing. Sections of flashing shall have an end lap of not less than 4 inches (102 mm). For roof slopes of 3 units vertical in 12 units horizontal (25-percent slope) and over, the valley flashing shall have a 36-inch-wide (914 mm) underlayment of one layer of Type I underlayment running the full length of the valley, in addition to other required underlayment.

1507.10 Built-up roofs. The installation of built-up roofs shall comply with the provisions of this section.

1507.10.1 Slope. Built-up roofs shall have a design slope of a minimum of one-fourth unit vertical in 12 units horizontal (2-percent slope) for drainage, except for coal-tar built-up roofs that shall have a design slope of a minimum one-eighth unit vertical in 12 units horizontal (1-percent slope).

1507.10.2 Material standards. Built-up roof covering materials shall comply with the standards in Table 1507.10.2.

1507.10.3 Red rosin paper. Red rosin paper shall be used when the membrane is applied directly to a wood deck or cementitious fiber decks.

1507.11 Modified bitumen roofing. The installation of modified bitumen roofing shall comply with the provisions of this section.

1507.11.1 Slope. Modified bitumen membrane roofs shall have a design slope of a minimum of one-fourth unit vertical in 12 units horizontal (2-percent slope) for drainage.

1507.11.2 Material standards. Modified bitumen roof coverings shall comply with CGSB 37-GP-56M, ASTM D 6162, ASTM D 6163, ASTM D 6164, ASTM D 6222, ASTM D 6223 or ASTM D 6298.

1507.12 Thermoset single-ply roofing. The installation of thermoset single-ply roofing shall comply with the provisions of this section.

1507.12.1 Slope. Thermoset single-ply membrane roofs shall have a design slope of a minimum of one-fourth unit vertical in 12 units horizontal (2-percent slope) for drainage.

1507.12.2 Material standards. Thermoset single-ply roof coverings shall comply with ASTM D 4637, ASTM D 5019 or CGSB 37-GP-52M.

1507.13 Thermoplastic single-ply roofing. The installation of thermoplastic single-ply roofing shall comply with the provisions of this section.

1507.13.1 Slope. Thermoplastic single-ply membrane roofs shall have a design slope of a minimum of one-fourth unit vertical in 12 units horizontal (2-percent slope).

1507.13.2 Material standards. Thermoplastic single-ply roof coverings shall comply with ASTM D 4434, ASTM D 6754, ASTM D 6878 or CGSB CAN/CGSB 37-54.

TABLE 1507.10.2
BUILT-UP ROOFING MATERIAL STANDARDS

MATERIAL STANDARD	STANDARD
Acrylic coatings used in roofing	ASTM D 6083
Aggregate surfacing	ASTM D 1863
Asphalt adhesive used in roofing	ASTM D 3747
Asphalt cements used in roofing	ASTM D 3019; D 2822; D 4586
Asphalt-coated glass fiber base sheet	ASTM D 4601
Asphalt coatings used in roofing	ASTM D1227; D 2823; D 4479
Asphalt glass felt	ASTM D 2178
Asphalt primer used in roofing	ASTM D 41
Asphalt-saturated and asphalt-coated organic felt base sheet	ASTM D 2626
Asphalt-saturated organic felt (perforated)	ASTM D 226
Asphalt used in roofing	ASTM D 312
Coal-tar cements used in roofing	ASTM D 4022; D 5643
Coal-tar saturated organic felt	ASTM D 227
Coal-tar pitch used in roofing	ASTM D 450; Type I or II
Coal-tar primer used in roofing, dampproofing and waterproofing	ASTM D 43
Glass mat, coal tar	ASTM D 4990
Glass mat, venting type	ASTM D 4897
Mineral-surfaced inorganic cap sheet	ASTM D 3909
Thermoplastic fabrics used in roofing	ASTM D 5665, D 5726

1507.14 Sprayed polyurethane foam roofing. The installation of sprayed polyurethane foam roofing shall comply with the provisions of this section.

1507.14.1 Slope. Sprayed polyurethane foam roofs shall have a design slope of a minimum of one-fourth unit vertical in 12 units horizontal (2-percent slope) for drainage.

1507.14.2 Material standards. Spray-applied polyurethane foam insulation shall comply with ASTM C 1029.

1507.14.3 Application. Foamed-in-place roof insulation shall be installed in accordance with the manufacturer's instructions. A liquid-applied protective coating that complies with Section 1507.15 shall be applied no less than 2 hours nor more than 72 hours following the application of the foam.

1507.14.4 Foam plastics. Foam plastic materials and installation shall comply with Chapter 26.

1507.15 Liquid-applied coatings. The installation of liquid-applied coatings shall comply with the provisions of this section.

1507.15.1 Slope. Liquid-applied roofs shall have a design slope of a minimum of one-fourth unit vertical in 12 units horizontal (2-percent slope).

1507.15.2 Material standards. Liquid-applied roof coatings shall comply with ASTM C 836, ASTM C 957, ASTM D 1227 or ASTM D 3468, ASTM D 6083 or ASTM D 6694.

SECTION 1508
ROOF INSULATION

1508.1 General. The use of above-deck thermal insulation shall be permitted provided such insulation is covered with an approved roof covering and passes the tests of FM 4450 or UL 1256 when tested as an assembly.

Exceptions:

1. Foam plastic roof insulation shall conform to the material and installation requirements of Chapter 26.
2. Where a concrete roof deck is used and the above-deck thermal insulation is covered with an approved roof covering.

1508.1.1 Cellulosic fiberboard. Cellulosic fiberboard roof insulation shall conform to the material and installation requirements of Chapter 23.

1508.2 Material standards. Above-deck thermal insulation board shall comply with the standards in Table 1508.2.

TABLE 1508.2
MATERIAL STANDARDS FOR ROOF INSULATION

Cellular glass board	ASTM C 552
Composite boards	ASTM C 1289, Type III, IV, V or VI
Expanded polystyrene	ASTM C 578
Extruded polystyrene board	ASTM C 578
Perlite board	ASTM C 728
Polyisocyanurate board	ASTM C 1289, Type I or Type II
Wood fiberboard	ASTM C 208

SECTION 1509
ROOFTOP STRUCTURES

1509.1 General. The provisions of this section shall govern the construction of rooftop structures.

1509.2 Penthouses. A penthouse or other projection above the roof in structures of other than Type I construction shall not exceed 28 feet (8534 mm) above the roof where used as an enclosure for tanks or for elevators that run to the roof and in all other cases shall not extend more than 18 feet (5486 mm) above the roof. The aggregate area of penthouses and other rooftop structures shall not exceed one-third the area of the supporting roof. A penthouse, bulkhead or any other similar projection above the roof shall not be used for purposes other than shelter of mechanical equipment or shelter of vertical shaft openings in the roof. Provisions such as louvers, louver blades or flashing shall be made to protect the mechanical equipment and the building interior from the elements. Penthouses or bulkheads used for purposes other than permitted by this section shall conform to the requirements of this code for an additional story. The restrictions of this section shall not prohibit the placing of wood flagpoles or similar structures on the roof of any building.

1509.2.1 Type of construction. Penthouses shall be constructed with walls, floors and roof as required for the building.

Exceptions:

1. On buildings of Type I and II construction, the exterior walls and roofs of penthouses with a fire separation distance of more than 5 feet (1524 mm) and less than 20 feet (6096 mm) shall be of at least 1-hour fire-resistance-rated noncombustible construction. Walls and roofs with a fire separation distance of 20 feet (6096 mm) or greater shall be of noncombustible construction. Interior framing and walls shall be of noncombustible construction.
2. On buildings of Type III, IV and V construction, the exterior walls of penthouses with a fire separation distance of more than 5 feet (1524 mm) and less than 20 feet (6096 mm) shall be at least 1-hour fire-resistance-rated construction. Walls with a fire separation distance of 20 feet (6096 mm) or greater from a common property line shall be of Type IV or noncombustible construction. Roofs shall be constructed of materials and fire-resistance rated as required in Table 601. Interior framing and walls shall be Type IV or noncombustible construction.
3. Unprotected noncombustible enclosures housing only mechanical equipment and located with a minimum fire separation distance of 20 feet (6096 mm) shall be permitted.
4. On one-story buildings, combustible unroofed mechanical equipment screens, fences or similar enclosures are permitted where located with a fire separation distance of at least 20 feet (6096 mm) from adjacent property lines and where not exceeding 4 feet (1219 mm) in height above the roof surface.
5. Dormers shall be of the same type of construction as the roof on which they are placed, or of the exterior walls of the building.

1509.3 Tanks. Tanks having a capacity of more than 500 gallons (2 m^3) placed in or on a building shall be supported on masonry, reinforced concrete, steel or Type IV construction provided that, where such supports are located in the building above the lowest story, the support shall be fire-resistance rated as required for Type IA construction.

1509.3.1 Valve. Such tanks shall have in the bottom or on the side near the bottom, a pipe or outlet, fitted with a suitable quick opening valve for discharging the contents in an emergency through an adequate drain.

1509.3.2 Location. Such tanks shall not be placed over or near a line of stairs or an elevator shaft, unless there is a solid roof or floor underneath the tank.

1509.3.3 Tank cover. Unenclosed roof tanks shall have covers sloping toward the outer edges.

1509.4 Cooling towers. Cooling towers in excess of 250 square feet (23.2 m^2) in base area or in excess of 15 feet (4572 mm) high where located on building roofs more than 50 feet (15 240 mm) high shall be of noncombustible construction. Cooling towers shall not exceed one-third of the supporting roof area.

Exception: Drip boards and the enclosing construction of wood not less than 1 inch (25 mm) nominal thickness, provided the wood is covered on the exterior of the tower with noncombustible material.

1509.5 Towers, spires, domes and cupolas. Any tower, spire, dome or cupola shall be of a type of construction not less in fire-resistance rating than required for the building to which it is attached, except that any such tower, spire, dome or cupola that exceeds 85 feet (25 908 mm) in height above grade plane, exceeds 200 square feet (18.6 m^2) in horizontal area or is used for any purpose other than a belfry or an architectural embellishment shall be constructed of and supported on Type I or II construction.

1509.5.1 Noncombustible construction required. Any tower, spire, dome or cupola that exceeds 60 feet (18 288) in height above the highest point at which it comes in contact with the roof, or that exceeds 200 square feet (18.6 m^2) in area at any horizontal section, or which is intended to be used for any purpose other than a belfry or architectural embellishment, shall be entirely constructed of and supported by noncombustible materials. Such structures shall be separated from the building below by construction having a fire-resistance rating of not less than 1.5 hours with openings protected with a minimum 1.5-hour fire-protection rating. Structures, except aerial supports 12 feet (3658 mm) high or less, flagpoles, water tanks and cooling towers, placed above the roof of any building more than 50 feet (15 240 mm) in height, shall be of noncombustible material and shall be supported by construction of noncombustible material.

1509.5.2 Towers and spires. Towers and spires where enclosed shall have exterior walls as required for the building to which they are attached. The roof covering of spires shall be of a class of roof covering as required for the main roof of the rest of the structure.

1509.6 Equipment and appliances on roofs or elevated structures. Where equipment and appliances requiring access are installed on roofs or elevated structures at a height exceeding 16 feet (4877 mm), such access shall be provided by a permanent approved means of access, the extent of which shall be from grade or floor level to the equipment and appliances' level service space. Such access shall not require climbing over obstructions greater than 30 inches (762 mm) high or walking on roofs having a slope greater than 4 units vertical in 12 units horizontal (33-percent slope).

Permanent ladders installed to provide the required access shall comply with the following minimum design criteria:

1. The side railing shall extend above the parapet or roof edge not less than 30 inches (762 mm).
2. Ladders shall have rung spacing not to exceed 14 inches (356 mm) on center.
3. Ladders shall have a toe spacing not less than 6 inches (152 mm) deep.
4. There shall be a minimum of 18 inches (457 mm) between rails.
5. Rungs shall have a minimum 0.75-inch (19 mm) diameter and be capable of withstanding a 300-pound (136.1 kg) load.
6. Ladders over 30 feet (9144 mm) in height shall be provided with offset sections and landings capable of withstanding 100 pounds (488.2 kg/m^2) per square foot.
7. Ladders shall be protected against corrosion by approved means.

Catwalks installed to provide the required access shall be not less than 24 inches (610 mm) wide and shall have railings as required for service platforms.

Exception: This section shall not apply to Group R-3 occupancies.

1509.7 Mechanical units. Roof mounted mechanical units shall be mounted on curbs raised a minimum of 8 inches (203 mm) above the roof surface, or where roofing materials extend beneath the unit, on raised equipment supports providing a minimum clearance height in accordance with Table 1509.7.

TABLE 1509.7
CLEARANCE BELOW RAISED ROOF MOUNTED MECHANICAL UNITS

WIDTH OF MECHANICAL UNIT (inches)	SURFACES (inches)
<24	14
24 < 36	18
36 < 48	24
48 < 60	30
> 60	48

For SI: 1 inch = 25.4 mm.

SECTION 1510
REROOFING

1510.1 General. Materials and methods of application used for recovering or replacing an existing roof covering shall comply with the requirements of Chapter 15.

Exception: Reroofing shall not be required to meet the minimum design slope requirement of one-quarter unit vertical in 12 units horizontal (2-percent slope) in Section 1507 for roofs that provide positive roof drainage.

1510.2 Structural and construction loads. Structural roof components shall be capable of supporting the roof-covering system and the material and equipment loads that will be encountered during installation of the system.

1510.3 Recovering versus replacement. New roof coverings shall not be installed without first removing all existing layers of roof coverings where any of the following conditions occur:

1. Where the existing roof or roof covering is water soaked or has deteriorated to the point that the existing roof or roof covering is not adequate as a base for additional roofing.
2. Where the existing roof covering is wood shake, slate, clay, cement or asbestos-cement tile.
3. Where the existing roof has two or more applications of any type of roof covering.
4. When blisters exist in any roofing, unless blisters are cut or scraped open and remaining materials secured down before applying additional roofing.
5. Where the existing roof is to be used for attachment for a new roof system and compliance with the securement provisions of 1504.1 can not be met.

Exceptions:

1. Complete and separate roofing systems, such as standing-seam metal roof systems, that are designed to transmit the roof loads directly to the building's structural system and that do not rely on existing roofs and roof coverings for support, shall not require the removal of existing roof coverings.
2. Reserved.
3. The application of a new protective coating over an existing spray polyurethane foam roofing system shall be permitted without tear-off of existing roof coverings.

1510.4 Roof recovering. Where the application of a new roof covering over wood shingle or shake roofs creates a combustible concealed space, the entire existing surface shall be covered with gypsum board, mineral fiber, glass fiber or other approved materials securely fastened in place.

1510.5 Reinstallation of materials. Existing slate, clay or cement tile shall be permitted for reinstallation, except that damaged, cracked or broken slate or tile shall not be reinstalled. Existing vent flashing, metal edgings, drain outlets, collars and metal counterflashings shall not be reinstalled where rusted, damaged or deteriorated. Aggregate surfacing materials shall not be reinstalled.

1510.6 Flashings. Flashings shall be reconstructed in accordance with approved manufacturer's installation instructions. Metal flashing to which bituminous materials are to be adhered shall be primed prior to installation.

SECTION 1511
RESERVED

SECTION 1512
HIGH-VELOCITY HURRICANE ZONES—GENERAL

1512.1 Scope. Sections 1512 through 1525 set forth minimum requirements for the installation of roofing components, roofing systems, roofing assemblies and the waterproofing thereof.

1512.2 Application. These high-velocity hurricane zone roofing requirements with associated roofing application standards (RAS) and testing application standards are solely to be implemented in areas of high basic wind speeds, and where the jurisdiction having authority has adopted their use.

1512.2.1 All roofing components, roofing systems and roofing assemblies for construction regulated by this code shall comply with this chapter. All roofing components, roofing systems and roofing assemblies shall have a valid and current Product Approval. In the event that the manufacturers published literature or instructions are in conflict with those of the Product Approval, the Product Approval shall prevail. Where items specifically and expressly addressed in this chapter are in conflict with the Product Approval, the provisions of this chapter shall prevail.

1512.2.2 Innovative products and/or systems outside those currently recognized under this chapter may have a product approval issued based on performance testing; in such case(s) the conditions set in the Product Approval shall prevail.

1512.2.3 For roofing systems to be installed on a specific building or structure, where an existing Product Approval may not be applied, such roofing system may be granted a one time approval by the authority having jurisdiction, provided the applicant demonstrates, by testing and/or rational analysis that such roofing system complies with the provision of this code.

1512.2.4 Where a Product Approval does not address a detail for a specific job condition, the permit applicant may propose to the building official an alternate detail to address the specific need of the job. The building official may accept such proposal if it can be demonstrated that the provisions of this code will be met.

1512.2.5 Workmanship standards. All roofing work shall be performed by a qualified contractor licensed to perform roofing, in compliance with the tolerances, quality and methods of construction established herein or set forth in the standards adopted by these high-velocity hurricane zone requirements. Roofing assemblies detailed in the Product Approval shall be installed in strict compliance with the method of application set forth in such Product Approval or, if not part of the product approval, in compliance with manufacturer's published application instructions, or as approved by the building official. (Aesthetic issues not affecting the performance of the roof are not part of this chapter.)

1512.2.5.1 Appearance. If the architectural appearance is to be preserved from below, an alternate method of attachment complying with the windload requirements of Chapter 16 (High-Velocity Hurricane Zones) may be proposed unless otherwise addressed in Chapter 15. The alternative attachment shall be prepared, signed and sealed by a Florida-registered architect or a Florida-registered engineer, which architect or engineer shall be proficient in structural design.

1512.3 Permits outside these high-velocity hurricane zone requirements shall comply with Section 105. Permits within high wind areas shall be required for all work in connection with the application, repair or maintenance of any roofing component or any roofing assembly and/or any of its components except as otherwise permitted in Section 105 of this code.

1512.3.1 All new roofing construction, including recovering and reroofing, repair or maintenance shall have a uniform roofing permit application, as established by the authority having jurisdiction, completed and executed by a licensed contractor.

1512.3.2 The uniform roofing permit shall include calculations per Chapter 16 (High-Velocity Hurricane Zone) of this code, unless the roofing assembly is less than the height/pressure threshold allowed in the applicable protocols herein.

1512.3.3 Reserved.

1512.3.4 Attachments to the uniform roofing permit application shall include two copies of each of the following documents: properly executed OWNERS NOTIFICATION FOR ROOFING CONSIDERATIONS herein; the fire directory listing pages, Product Approval, and applicable detail drawings; the municipal permit application; other components approvals; and any other additional data reasonably required by the authority having jurisdiction needed to determine the integrity of the roofing system.

1512.3.5 In new construction, a licensed roofing contractor may dry-in the wood deck (no mopping) on a specific structure, prior to the roofing permit being issued provided:

1512.3.5.1 The master building permit for that specific structure has been obtained;

1512.3.5.2 The sheathing inspection has been made and approved by the building official; and

1512.3.5.3 The required roofing permit application is submitted to the building official within 10 days after dry-in work is started and the slope of the roof deck is 2:12 or greater.

1512.4 Inspections performed outside these high-velocity hurricane zone requirements shall comply with Section 109.

1512.4.1 All roofing work for which a permit is required shall be inspected by the building official. One or more inspections may be performed at the same time at the request of the roofing contractor or when feasible. Lack of roofing contractor's personnel at the job site, in and of itself, shall not be cause to fail the inspection. Certain roofing inspections shall be performed during specific phases of the applications as noted below:

1512.4.2 For discontinuous roofing systems (as defined herein or Chapter 2):

1512.4.2.1 During or after application of the base sheet, anchor sheet or underlayment of any roofing system.

1512.4.2.2 During the installation of the cap sheet.

1512.4.2.3 During the installation of any prepared roof covering, such as shingles, tiles, slates, shakes and similar.

1512.4.2.4 Upon completion of all adhesive-set and mortar-set tile systems, and prior to the final inspection, a field verification and static uplift test, in compliance with TAS 106 shall be required to confirm tile adhesion to the underlayment. This test may be required by the building official for mechanically attached tile systems. All results of this test shall be submitted to the building official.

1512.4.3 For continuous roofing systems (as defined in herein or Chapter 2):

1512.4.3.1 During application of any roofing system prior to the full concealment of the adhesion/attachment process to the roof deck or to the existing roofing assembly.

1512.4.3.2 In cases where a roof area is less than 1,500 square feet (139 m^2), and when the building official is not able to perform any of the above requested inspection in a timely manner, the building official may authorize to continue with the work and may require that satisfactory evidence be provided to show that the covered work was performed in compliance with this code.

1512.4.3.3 After all roofing work has been completed, a final inspection shall be performed by the building official.

SECTION 1513
HIGH-VELOCITY HURRICANE ZONES—DEFINITIONS

1513.1 Definitions. For definitions outside Sections 1512 through 1525 and accompanied RAS and TAS, see Chapter 2. For the purposes of Sections 1512 through 1525, accompanying RAS, TAS and roofing Products Approval, roofing terms shall be defined in compliance with ASTM D 1079, unless otherwise defined below. The definitions listed below shall take preference. Other terms used herein shall be defined as set forth in Chapter 2 of this code.

AIR PERMEABLE ROOFING SYSTEM. A roofing system consisting of a prepared roof covering over an approved underlayment on a sloped roof. The components within the prepared roof covering are discontinuously laid and small, with unsealed side and head laps. Air permeable roofing systems shall be applied over sheathed decks with either mechanical attachment or a mortar/adhesive bond. Any roofing system with sealed side or head laps shall not be defined as an air permeable roofing system. The authority having jurisdiction may require testing in compliance with TAS 116, to determine whether a roofing system is air permeable.

ANCHOR SHEET. A roofing felt mechanically attached to a nailable deck with approved fasteners to which insulation is then installed in a solid mopping of asphalt. The roofing membrane is then installed to the insulation in the usual manner.

ARCHITECTURAL METAL PANEL. Water shedding (hydrokinetic) roof panel fastened to a roof deck.

ASTM (ASTM International). A scientific and technical organization that is responsible for the development of standards on characteristics and performance of materials, products, systems, as adopted for the high-velocity hurricane zone.

NET FREE VENTILATING AREA (NFVA). The gross area of the smallest plane area of the ventilating device reduced by the percentage of physical obstruction to the plane area.

BASE SHEET. The bottom or first ply of a roofing assembly over which subsequent roofing plies are applied. A base sheet may be designed for mechanical attachment, full or partial adhesion to the substrate.

"CLASS A" ROOFING ASSEMBLY. A roofing assembly that, in combination with the roof slope, has been classified by an approved testing agency, with a listing and follow-up service, as "Class A" in compliance with ASTM E 108 or UL 790.

"CLASS B" ROOFING ASSEMBLY. A roofing assembly that, in combination with the roof slope, has been classified by an approved testing agency, with a listing and follow-up service, as "Class B" in compliance with ASTM E 108 or UL 790.

"CLASS C" ROOFING ASSEMBLY. A roofing assembly that, in combination with the roof slope, has been classified by an approved testing agency, with a listing and follow-up service, as "Class C" in compliance with ASTM E 108 or UL 790.

CONTINUOUS ROOFING SYSTEM. An impervious roof covering, composed from a single or multiple layers, forming a homogenous membrane over the entire roof surface, applied to either a flat or pitched roof surfaces.

CORROSION RESISTANT. Any component that passes appendix of FMRC's Test Standard 4470, as modified, and set forth in TAS 114.

COUNTER BATTENS. Vertical wood strips installed on sloped roofs over which horizontal battens are secured. The primary roof covering is attached or secured to these horizontal battens.

COUNTERFLASHING. Formed metal or elastomeric sheeting secured on or into a wall, curb, pipe, roof-top unit or other surface to cover and protect the upper edge of a base flashing and its associated fasteners.

DISCONTINUOUS ROOFING SYSTEM. A roofing system with unsealed overlapping components, where the combined roofing system has openings at the point of overlap, applied to a sloped surface with a pitch of 2:12, or greater. Discontinuous roofing systems include asphalt shingles; concrete, clay or metal tile; wood shingles or shakes; and cement fiber roofing systems.

DRY-IN. The process of applying the first layer of felt in a roofing system.

FMRC (Factory Mutual Research Corporation). A research and testing organization that is responsible for examination and testing of construction and other products on behalf of member insurance companies.

FASTENER WITHDRAWAL RESISTANCE TEST. A static pullout test of mechanical fasteners, which are used to anchor any roofing component, to determine the force required to withdraw a fastener from the substrate. Testing shall be in compliance with the test procedure detailed in TAS 105.

FIRE-RESISTANT ROOF COVERING. Any Class A, Class B or Class C roofing system applied to the appropriate deck type within the specified slope of the listed classification.

FLASHING. The roofing component used to seal roofing systems, where the system is interrupted or terminated.

LAP. See NRCA Manual, 4th edition.

METAL PROFILE. Including but not limited to eave and gable drip, gravel stop, raised edge systems and fascia systems. All composite and nonmetallic flashing materials shall have a Product Approval.

MINIMUM CHARACTERISTIC RESISTANCE FORCE. A force or pressure which is representative of data from withdrawal resistance testing; static uplift testing; and/or wind uplift testing after the data has been statistically analyzed to a 95-percent level of precision.

METAL ROOF PANEL. An interlocking metal sheet having an installed weather exposure equal or greater than three square feet per sheet.

METAL ROOF SHINGLE. An interlocking metal sheet having an installed weather exposure less than 3 square feet (.3 m^2) per sheet.

MOMENT. A quantity that represents the affect of a force applied at a particular point in relation to a specific point or axis.

NRCA. The NRCA *Roofing and Waterproofing Manual*, 5th edition, as published by the National Roofing Contractors Association.

PREPARED ROOF COVERING. Any manufactured or processed roof covering designed for use as the top layer of a discontinuous roofing system applied to a sloped roof.

RAS. Roofing Application Standards.

RECOVERING. The process of covering an existing roofing assembly with a new roofing system or a prepared roofing system.

REPAIR. The work of corrective procedures by replacing or altering an existing roofing component or system to eliminate water intrusion.

REROOFING. The process of recovering or replacing an existing roofing system, either in its entirety or in existing sections.

RIDGE VENT. A ventilator located within 18 inches (457 mm) of the ridge that allows the escape of warm and/or moist air from the attic area or rafter cavity.

ROOFING ACCESSORY. A type of roofing product as described in Section 1517.6 of this code.

ROOFING ASSEMBLY. An assembly of interacting roofing components [includes the roof deck, vapor retarder (if present), insulation, and roof covering].

ROOFING COATINGS, ADHESIVES AND MASTICS. Any and all liquid materials applied to the roofing membrane layer to enhance ultraviolet light resistance; increase resistance to fire; increase reflectivity of the roofing assembly; or, in some way, enhance the performance of the roofing assembly. Roofing coatings, adhesives or mastics shall not contain asbestos materials.

ROOF COVERING. An assembly of multiple field-applied components or a single component designed to weatherproof a building's top surface. A roof covering may be a roofing assembly or form a portion thereof.

ROOFING COMPONENT. A roofing product that is incorporated into various roofing assemblies.

ROOF DECK. Solid or spaced sheathing to which the roofing or waterproofing system is applied.

ROOFING MAINTENANCE. Is the work of extending the longevity of a roofing system through preventative care, such as refilling pitch pans, applying coatings, regraveling, resurfacing and recaulking.

ROOF SECTION. A separation or division of a roof area by existing expansion joints, parapet walls, flashing (excluding valleys), difference of elevation (excluding hips and ridges), roof type or legal description; not including the roof area required for a proper tie-off with an existing system.

ROOFING SYSTEM. A system of interacting roofing components, generally consisting of membrane or primary roof covering and insulation (not including the roof deck) designed to weatherproof, and sometimes to improve, the building's thermal resistance.

HIGH ROOF TILE PROFILE. Those tiles having a rise-to-width ratio greater than 0.20.

LOW ROOF TILE PROFILE. Those tiles having a rise-to-width ratio less or equal than 0.20; except those tiles meeting the flat profile definition.

FLAT ROOF TILE PROFILE. Those tiles with less than $^1/_2$-inch (12.7 mm) rise.

STRUCTURAL METAL PANEL. Roof covering intended to be self-supporting between structural members (see Sections 2003.8.2 and 2222.4).

TAS. Testing Application Standard.

UNDERLAYMENT. One or more water-shedding layers applied to a sloped roof prior to the application of a prepared roof covering. The primary purpose of an underlayment is defined as a water shedding layer to function in combination with a prepared roof covering.

WOOD SHAKES. Tapered or straight pieces of red cedar, or other wood types, of widths ranging from 3 inches to 14 inches (76 mm to 356 mm) ranging in lengths from 18 inches to 32 inches (457 mm to 813 mm) applied to a sloped roof, in conjunction with an approved underlayment, forming a discontinuous prepared roof system.

WOOD SHINGLES. Tapered pieces of red cedar, or other wood types, sawn on both faces, of widths ranging from 3 inches to 14 inches (356 mm) and lengths of 16 inches (406 mm), 18 inches (457 mm), and 24 inches (610 mm) applied to a sloped roof forming a discontinuous prepared roof system.

SECTION 1514
HIGH-VELOCITY HURRICANE ZONES—WEATHER PROTECTION

1514.1 General. Roof decks shall be covered with roof coverings secured to the building or structure in accordance with the provisions of this chapter. Roof coverings shall be designed, installed and maintained in accordance with this code and the manufacturer's installation instructions such that the roof covering shall serve to protect the building or structure. All roof coverings, roof systems and roof assemblies shall be designed and installed to resist the windload requirements of Chapter 16 (High-Velocity Hurricane Zones) of this code.

1514.2 Flashings. Flashings shall be installed in such a manner as to prevent moisture entering the wall through the joints in the coping, through moisture permeable materials, at intersections with the roof plane or at parapet wall penetrations. All roof flashing and terminations shall be designed and installed to resist the windload requirements of Chapter 16 (High-Velocity Hurricane Zone) of this code, and shall be in compliance with the provisions set forth in RAS 111.

1514.2.1 Locations. Flashings shall be installed at (1) wall and roof intersections, (2) at gutters, (3) wherever there is a change in roof slope or direction, this requirement does not apply to the hip and ridge junctions, and (4) around roof openings. Where flashing is of metal, the metal shall conform with the provisions of RAS 111.

1514.2.2 Membrane flashings. All membrane flashing shall be installed according to the roof assembly manufacturer's published literature and in accordance with the provisions set forth in RAS 111.

1514.2.3 Metal flashings and terminations. Metal flashing and terminations shall be of the material and thickness described in Section 1517.6 and RAS 111 of this code, and shall be designed and installed in accordance with RAS 111. Metal flashing shall be installed after the roofing felts have been laid and turned up the vertical surfaces, in compliance with the roofing assembly Product Approval.

1514.2.3.1 Such felts shall be embedded in hot bitumen or an approved adhesive.

1514.2.3.2 Metal surfaces shall be primed with an ASTM D 41 or ASTM D 43 primer, as appropriate and allowed to dry prior to receiving hot bitumen or cold adhesive.

1514.2.4 Metal counterflashing. Metal counterflashing shall be of the material and thickness described in Section 1517.6 and RAS 111 of this code, and shall be installed in accordance with RAS 111.

1514.2.4.1 Metal counterflashing shall be built into walls, set in reglets or applied as stucco type and shall be turned down over base flashing not less than 3 inches (76 mm).

1514.2.4.2 Metal counterflashing shall be side lapped a minimum of 4 inches (102 mm).

1514.2.4.3 Metal counterflashing, where set in reglets or surface-mounted, shall be waterproofed, in accordance with applicable application standards.

1514.2.4.4 Where metal counterflashing is used as the means of sealing (such as a vented system) it shall be set in an approved sealant, sealed with an approved adhesive on the top flange and all joints shall be sealed with an approved sealant and lapped a minimum of 4 inches (102 mm).

1514.2.5 Roof penetration flashing.

1514.2.5.1 All pipes shall be flashed with approved lead sleeve-type, pitch pans or other approved methods detailed in the roofing system assembly Product Approval. Lead flashing shall not be less than 2.5 pounds per square foot (12.2 kg/m^2). Flanges shall be a minimum of 4 inches (102 mm).

1514.2.5.2 Other roof penetrations shall be suitably flashed with curbs, collars, pitch pans, in compliance with RAS 111 or an approved method, in compliance with the roofing system assembly Product Approval.

1514.2.5.3 No roof penetration shall be located in roof valleys.

1514.3 Coping. Where required, parapet walls shall be properly coped with noncombustible, weatherproof materials of a width no less than the thickness of the parapet wall. Copings shall be designed and installed to resist the windload requirements of Chapter 16 (High-Velocity Hurricane Zones) of this code, and shall be in accordance with the provisions set forth in RAS 111.

1514.4 Roof drainage. Unless roofs are sloped to drain over roof edges, roof drains shall be installed at each low point of the roof. Where required for roof drainage, scuppers shall be placed level with the roof surface in a wall or parapet. The scupper shall be located as determined by the roof slope and contributing roof area. Scuppers shall be sized in accordance with the provisions contained in ASCE 7, Section 8 with commentary and shall comply with Section 1617 herein.

1514.4.1 Gutters. Gutters and leaders placed on the outside of buildings, other than one- or two-family dwellings, private garages and buildings of Type II-B construction, shall be of noncombustible material or a minimum of Schedule 40 plastic pipe.

1514.4.1.1 Gutters and leaders shall be constructed of metal or approved plastic for outdoor exposure with lapped, soldered or caulked joints and shall be securely fastened to the building with a corrosion resistant fastening device of similar or compatible material to the gutters and downspouts. Gutters shall be in compliance with RAS 111.

1514.4.2 Overflow drains and scuppers. Where roof drains are required, overflow drains or overflow scuppers sized in accordance with *Florida Building Code, Plumbing* shall be installed with the inlet flow line located not less than 2 inches (51 mm) or more than 4 inches (102 mm) above the low point of the finished roofing surface, excluding sumps. Overflow scuppers shall be a minimum of 4 inches (102 mm) in any dimension and shall be located as close as practical to required vertical leaders, conductors or downspouts. Overflow drains and scuppers shall also comply with the *Florida Building Code, Plumbing*, and Section 1617 of this code.

1514.4.2.1 When overflow scuppers and roof drains are installed, they shall be lined with approved metal or other approved materials set forth in the roofing system assembly Product Approval.

1514.4.2.2 When recovering, reroofing or repairing an existing roof, the existing number of scuppers and/or roof drains shall not be reduced, unless a new drainage system is designed by an architect or engineer, in compliance with the provisions of this code.

1514.4.3 Sizing and discharge. Roof drains, gutters, conductors and leaders shall be sized and discharge in accordance with the *Florida Building Code, Plumbing*.

SECTION 1515
HIGH-VELOCITY HURRICANE ZONES—PERFORMANCE REQUIREMENTS

1515.1 General. All roof assemblies, roof coverings and roof systems shall have Product Approval, and shall meet the following minimum requirements.

1515.1.1 All continuous roofing assemblies shall be tested in compliance with FMRC Test Standards 4470 and/or 4471 (for metal roofing), as modified for the purposes of this code and set forth in TAS 114. Only those components listed within the roofing assembly Product Approval shall be approved for use with the roof covering. Roofing assemblies shall be acceptable for use in this code's jurisdiction providing they are in compliance with the fire classification required for the structure to which the roofing assembly is to be installed.

1515.1.2 All fastening devices and fastening assemblies used for insulation, anchor sheet or roof coverings shall be tested in compliance with Section 1523 of this code.

1515.1.3 All roofing assemblies shall be tested by a testing laboratory, certified by the certification agency in accordance with TAS 301, to confirm compliance with the fire classification and other sections of this code.

1515.1.4 All roofing membranes and components shall be tested in compliance with the physical property test requirements detailed in TAS 110.

1515.1.5 No loose laid ballasted or nonballasted system shall be allowed.

1515.2 Guidelines for roofing applications.

1515.2.1 Decks. All roofing systems and prepared roof coverings shall be installed over solid decks, unless otherwise specifically allowed in other sections of this code.

1515.2.2 Minimum slope. All roofing assemblies must be installed in compliance with the slope requirements specified in the product control approval, in compliance with Table 1515.2.

TABLE 1515.2
MINIMUM SLOPE

SYSTEM TYPE	SLOPE	
Fibrous Cement Shingles	4:12	
Metal Panels	Architectural	
	2:12	
Metal Shingles	4:12	
Tile	Mortar or Adhesive	
	2:12 (min) to 7:12 (max) unless tested for steeper slope and it is noted in Product Approval	
	Mechanically Fastened	
	Direct Deck	Battens
	4:12	
Asphaltic Shingles	Dimensional	3-tab
	2:12	2:12
Quarry Slate	$3^1/_2$:12	
Wood	Shakes	Shingles
	4:12	$3^1/_2$:12

1515.2.2.1 All roofing systems must be installed to ensure positive drainage. In new construction the minimum deck slope shall be not less than $^1/_4$:12.

1515.2.2.2 All roofing assemblies shall be installed at a slope no greater than the maximum allowed for the required fire classification.

1515.2.3 Deck preparation. All roof decks, substrates, existing roofing systems to which a new roofing assembly is to be installed shall be broom cleaned, free from dirt and silt and dry prior to commencement of the roofing application.

1515.2.3.1 Cant strips, if required, shall be extended not less than 3-inch (76 mm) up vertical flashing surfaces, measured from the top of the new roof covering.

1515.2.3.2 All eaves shall provide a firm nailable substrate for secure attachment of perimeter edge metal in compliance with RAS 111.

1515.2.3.3 Perimeter edge metal shall be fastened with nails or fasteners fabricated from similar or compatible material. The nails or fasteners shall be as set forth in the roofing assembly Product Approval.

1515.2.3.4 All precast and prestressed concrete deck components shall be leveled with leveling fill, where such components' edges are greater than $^1/_2$ inch (12.7 mm) from being flush.

1515.2.4 Impact resistance. Roof coverings installed on low slope roofs in accordance with Section 1519 shall resist impact damage based on the results of test conducted in accordance with ASTM D 3746, ASTM D 4272, CGSB 37, FM 4470 or TAS 114.

1515.2.5 Ridge vents. Ridge vents shall have a Product Approval, and shall be tested for wind driven rain in accordance with TAS 110 and Section 1523.

SECTION 1516
HIGH-VELOCITY HURRICANE ZONES—FIRE CLASSIFICATION

1516.1 General. Roof assemblies shall be divided into the classes defined below. Class A, B and C roof assemblies and roof coverings required to be listed by this section shall be tested in accordance with ASTM E 108 or UL 790. In addition, fire retardant treated wood roof coverings shall be tested in accordance with ASTM D 2898.

1516.2 Fire resistant roofing assemblies and coverings shall be provided on all structures. Fire classification of roofing assemblies and coverings shall be based on the exposure hazard as follows:

1516.2.1 Class A. Zero feet to 20 feet (0 to 6.1 m) distance separation measured horizontally from the closest point of any building edge to the nearest point to an adjoining structure, and all buildings with occupation greater than 300 persons.

Exception: Brick, masonry, slate, clay or concrete roof tile and exposed concrete roof deck are considered to meet Class A roof covering provisions without testing.

1516.2.2 Class B. All other structures, except as noted below

1516.2.3 Class C. Structures not occupied by humans.

SECTION 1517
HIGH-VELOCITY HURRICANE ZONES—MATERIALS

1517.1 Scope. Every roofing component shall comply with the applicable ASTM material standards adopted by this code. All such products shall bear the testing logo imprinted on the material and/or container or shall be marked in a distinctive manner to define compliance with the standards and shall be subject to be evaluated for compliance. The certification agency shall carry out random testing of labeled products to confirm compliance with ASTM material standard.

1517.2 Compatibility of materials. Roofs and roof coverings shall be of materials that are compatible with each other and with the building or structure to which the materials are applied.

1517.3 Material specification and physical characteristics. No roofing component containing asbestos shall be used in any roofing assembly.

1517.4 Product identification. All roofing components shall be labeled and/or identified as mandated by the Product Approval.

1517.4.1 ASTM standard roll goods shall be marked with a yellow line to identify the ASTM standard, or such other marking as may be deemed appropriate by the Product Approval.

1517.5 Fasteners.

1517.5.1 Nails shall be minimum 12 gage, annular ring shank nails having not less than 20 rings per inch, heads not less than $^3/_8$ inch (9.5 mm) in diameter; and lengths sufficient to penetrate through the thickness of plywood panel or wood plank decking not less than $^3/_{16}$ inch (4.8 mm), or to penetrate into a 1 inch (25 mm) or greater thickness of lumber not less than 1 inch. Nails or wood screws shall be hot dipped electro or mechanically galvanized to a thickness sufficient to resist corrosion in compliance with TAS 114, Appendix E, Section 2 (ASTM G 85). All nails shall be listed by a certification agency. All nail cartons or carton labels shall be labeled to note compliance with the corrosion resistance requirements. No roofing material shall be fully or partially adhered directly to a nailable deck, unless otherwise noted in the roof assembly Product Approval.

1517.5.2 "Tin caps" shall be not less than $1^5/_8$ inches (41 mm) and not more than 2 inches (51 mm) in diameter and of not less than 32 gage (0.010 inch) sheet metal. "Cap nails" or prefabricated fasteners with integral heads complying with this section shall be an acceptable substitute. All "tin caps," "cap nails" or prefabricated fasteners with integral heads shall be tested for corrosion resistance in compliance with TAS 114 Appendix E, Section 2 (ASTM G 85), and shall be product control listed. All of cartons or carton labels "tin caps," "cap nails" or prefabricated fasteners with integral heads shall be labeled to note compliance with the corrosion resistance requirements.

1517.6 Metal roofing accessories. All metal accessories for roofs shall be not less than 26 gage G-90 galvanized or stainless steel, 16 ounce copper, 0.025-inch (0.6 mm) thick aluminum, lead sheet with a minimum 2.5 lb/sf (12.2 kg/m^2) or equivalent noncorrosive metal alloys or composite materials manufactured for use as roof termination. All composite and nonmetallic flashing materials shall have a Product Approval.

1517.6.1 Metal accessories may be of a manufactured, shop-fabricated or field-fabricated type, providing the materials and fasteners are in compliance with the minimum requirements of this code and shall be sized, designed and installed in compliance with methods set forth in RAS 111.

1517.6.2 Gravel stop or drip edge profiles shall be as follows:

1517.6.2.1 The vertical face shall be a minimum of $1^1/_2$ inches (38 mm) and shall extend down not less than $^1/_2$ inch (12.7 mm) below the sheathing or other member immediately contiguous thereto. In all cases, the deck flange shall be not less than 2 inches (51 mm) in width. Gravel stop or drip edge shall be sized, designed and installed in compliance with RAS 111.

1517.6.2.2 Gravel stop or drip edge shall be designed so that the bottom (the kick of the metal) of the drip edge shall have a minimum of $^1/_2$-inch (12.7 mm) clearance from the structure.

1517.6.2.3 Gravel stops or eaves drip shall be installed in compliance with RAS 111.

1517.6.2.4 Gravel stops shall be installed after all roofing felts have been applied, or in compliance with the application method set forth in the roofing assembly Product Approval. All asphalt or approved cold adhesive bonding areas shall be coated with ASTM D 41 or ASTM D 43, as required, and allowed to dry prior to application.

1517.6.2.5 Gravel stops and drip edges shall be joined by lapping a minimum of 4 inches (102 mm) and the entire interior of the joints shall be coated with approved flashing cement. Cover and splice plates shall be of the same material as the gravel stop and drip edge, and shall be sized, fabricated and installed in compliance with RAS 111.

1517.6.2.6 The deck flange shall be nailed with an approved minimum 12 gage annular ring shank nail at 4 inches (102 mm) o.c. The nail shall be manufactured from similar and/or compatible material to the termination profile. All composite materials shall be fastened with nonferrous nails.

1517.6.3 Valley metal. Valley metal shall be of the materials set forth in Section 1517.6.

SECTION 1518
HIGH-VELOCITY HURRICANE ZONES—ROOF COVERINGS WITH SLOPES 2:12 OR GREATER

1518.1 General. Prepared roof coverings shall be as defined in Section 1513 and in general limited to application over sloped roof decks capable of receiving mechanical fasteners. Prepared roof coverings may be mechanically fastened or, in specific limited cases noted in the Product Approval, set in an adhesive bond.

1518.2 Underlayments. Underlayment shall be as defined in Secion1513. Underlayment shall be installed in compliance with the roofing component Product Approval and shall be in compliance with the following minimum requirements:

1518.2.1 Underlayment shall be attached to a nailable deck in a grid pattern of 12 inches (305 mm) between the overlaps, with 6-inch (152 mm) spacing at the overlaps.

1518.2.2 Where the architectural appearance of the underside is to be preserved, the underlayment shall be secured in accordance with Section 1519.5.2.

1518.2.3 Tin caps and nails or cap nails shall be applied as defined in Section 1517.5.2.

1518.2.4 Underlayment nails shall be as defined in Section 1517.5.1.

1518.3 If the underlayment is a self-adhering membrane, the membrane shall be applied over a mechanically attached anchor sheet, attached in compliance with Section 1518.2.1.

1518.4 All underlayment applications for prepared roof coverings shall be applied in compliance with the manufacturer roofing assembly Product Approval, and shall be not less than one of the following: (1) A double layer of an ASTM D 226 Type I, with a 19-inch (483 mm) headlap; or (2) A single layer of an ASTM D 226, type II with a 4-inch (102 mm) headlap; or (3) A single layer of an ASTM D 2626 coated base sheet with a 4 inch (102 mm) headlap, and (4) All endlaps shall be a minimum of 6 inches (152 mm).

1518.5 Fiber cement shingles. Fiber-cement shingles shall be applied in compliance with the shingle manufacturer's roofing assembly Product Approval. The roofing system assembly Product Approval shall meet the following minimum requirements:

1518.5.1 All nonasbestos fiber-cement shingles shall conform to ASTM C 1225.

1518.5.2 Fiber-cement shingles shall be installed in compliance with the nailing requirements set forth in the Product Approval; however, attachment of each component shall be with not less than two corrosion resistant fasteners. If adhesive is used at the head or side laps, the system shall be defined as a "sealed system" with load calculations in compliance with Chapter 16 (High-Velocity Hurricane Zones).

1518.5.3 All intersections shall be flashed in metal as provided in Section 1517.6 and RAS 111.

1518.5.4 Fiber-cement shingles shall be tested as set forth in Section 1523.

1518.6 Quarry slate. Quarry slates shall be applied in compliance with the slate manufacturer's Product Approval. The roofing assembly Product Approval shall meet the following minimum requirements:

1518.6.1 Quarry slates shall be installed with not less than two approved fasteners per slate.

1518.6.2 All terminations and intersections shall be flashed in metal as provided in Section 1517.6 and RAS 111.

1518.6.3 Quarry slates shall be tested in compliance with the requirements set forth in Section 1523.

1518.6.4 Installation of all quarry roof slates shall be limited to a roof mean height of 33 feet (10 m), unless otherwise specifically noted in the Product Approval.

1518.7 Asphaltic shingles. Asphaltic shingles layout, alignment and placement of mechanical attachment shall be in compliance with the Product Approval, and shall be installed in accordance with RAS 115.

1518.7.1 Underlayments exceeding minimum underlayments, as detailed in Section 1518, shall be applied in compliance with the application methods detailed in the Product Approval. Where the architectural appearance of the underside of the roof is to be preserved, refer to Section 1519.5.2.

1518.7.2 Installation of all asphaltic shingles shall be limited to a roof mean height of 33 feet (10 m), unless otherwise specifically noted in the Product Approval.

1518.7.3 The asphaltic shingle Product Approval shall meet the following minimum requirements.

1518.7.3.1 Where asphaltic shingles are to be installed over insulated roof deck, a suitable nailable substrate, in accordance with Section 1520.5.7 must be installed over the insulation prior to the installation of approved underlayment and shingles.

1518.7.3.2 Asphaltic shingles shall be installed in compliance with the Product Approval, but in no case with less than six approved roofing nails or approved fastening devices which penetrate through the thickness of sheathing or wood plank a minimum of $^3/_{16}$ inch (4.8 mm) or penetrate into a 1 inch (25 mm) or greater thickness of lumber a minimum of 1 inch (25 mm), except where architectural appearance is to be preserved, in which case a minimum of $^3/_4$ inch (19 mm) ring shank roofing nail may be used.

1518.7.3.3 Intersections, eaves, rakes, valleys, gable ends, and the starter course of asphaltic shingles shall be set in an 8-inch (203 mm) wide bed of approved cold adhesive or roofing cement. Application of adhesive or cement shall be in compliance with the application instructions of the Product Approval. Shingles shall not extend more than $^1/_4$ inch (6.4 mm) beyond the eave drip.

1518.7.3.4 All perimeter termination and valleys shall be fabricated from metal. Minimum metal requirements are set forth in Section 1517.6 and RAS 111.

1518.7.3.5 Asphaltic shingles shall be tested in compliance with the provisions set forth in Section 1523.

1518.8 Clay and concrete roof tile. Tile shall be clay, concrete or composition material of various configurations complying with the physical property requirements of this code. All tile and tile systems shall be tested in compliance with the provisions set forth in Section 1523. Tile shall have a product approval for a complete tile system, which shall include the tile, underlayment and all tile related accessories required to provide a waterproof system.

1518.8.1 Application. All tile systems shall be installed over solid sheathed decks. All tile installation shall be in accordance with RAS 118, RAS 119, and RAS 120, as applicable.

1518.8.1.1 Roof tile mortar shall either be a pre-mixed unit having a Product Approval and tested in compliance with TAS 123 or a job-site mix approved by the building official and in compliance with RAS 113.

1518.8.2 The roof tile Product Approval shall specify the slope requirement for each tile and underlayment system in accordance with Table 1515.2.

1518.8.3 All roof tile fasteners shall be tested and comply with the requirements set forth in Section 1523.

1518.8.4 All tile systems. All tile application designs shall comply with the following limitations in order to withstand the wind loads prescribed in this section, as well as all wind load requirements set forth in Chapter 16 (High-Velocity Hurricane Zones).

1518.8.4.1 Roof tile systems, combining mechanically fastened tile and mortar and/or adhesive, shall be acceptable.

1518.8.4.2 In an air permeable tile roofing systems: (1) the length of each tile shall be not less than 12 inches (305 mm) and not greater than 21 inches (533 mm) and the exposed width of the tile shall be between 8.5 inches and 15 inches (216 and 381 mm); (2) the maximum thickness of the nose (leading edge) of the tile shall not exceed 1.3 inches (33 mm); and (3) mortar or adhesive set system shall have at least two-thirds of the tile free of mortar and/or adhesive contact.

1518.8.5 The proposed method of attachment for tile systems which are considered to be air permeable, shall provide sufficient attachment resistance (Mf) (listed in tile product approval) to meet or exceed the moment of resistance (M_r) as determined by following the procedures outlined in RAS 127. The aerodynamic multiplier (k) needed in RAS 127 shall be part of the tile Product Approval and shall be derived from the following formula:

for direct deck application **k = (0.156) × (b) × (l)2**

for batten application **k = (0.144) × (b) × (l)2**

Where b (in feet) = exposed width of the tiles

Where l (in feet) = length of tiles

1518.8.6 The proposed method of attachment for tile systems which are not considered air permeable shall provide a minimum characteristic force (F') (listed in tile product control approval) to meet or exceed the required uplift resistance (Fr) as determined by following the procedures outlined in RAS 127.

1518.8.7 Tile systems shall extend beyond the drip edge (not including the rake) not less than $^3/_4$ inch (19 mm) but not more than 2 inches (51 mm).

1518.8.8 Spanish "S" tile, barrel tile or other tile systems that create a void between the deck and the underside of the tile shall be closed at the eaves with a prefabricated closure or mortar filler to close the eaves and elevate the butt ends of the first course, as detailed in the tile system Product Approval.

1518.8.9 Apply a minimum $^3/_8$-inch (9.5 mm) diameter weephole, spaced not more than 12 inches (305 mm) apart, located flush with the underlayment of all tile systems, except tile systems using thick-butt tile.

1518.8.10 Mortar or adhesive set tiles applied at an incline from 6:12 up to and including 7:12 shall have the first course of tile (this applies to pan only on two-piece barrel tile) mechanically fastened with not less than one fastener per tile. As an alternate, the first course of tile shall be applied in mortar over a single layer of minimum 20 gage galvanized wire mesh with openings of not less than $^1/_2$ inch (12.7 mm) or greater than $1^1/_2$ inches (38 mm) with minimum exposure of 12 inches (305 mm) which is mechanically attached to the deck through the underlayment with approved fasteners and tin-cap when backnailing the cap sheet. Additionally, for roof inclines of 6:12 up to and including 7:12, every third tile of every fifth course, shall be mechanically fastened with not less than one fastener per tile. For roof inclines above 7:12, in addition to the mortar or adhesive, all tiles shall be mechanically fastened with not less than one fastener per tile. Apply approved flashing cement to seal all tile fastener penetrations, for all roof inclines.

1518.8.11 All tile systems shall be shingle lapped interlocking and installed with the headlap as specified in the tile system Product Approval. In no case shall the minimum headlap be less than 2 inches (51 mm) for mortar or adhesive set tile, or less than 3 inches (76 mm) for mechanically set tile, unless restricted by product design.

1518.8.12 Where tiles are to be installed over an insulated roof deck, a suitable nailable substrate, in accordance with Sections 1520.5.6 and 1520.5.7 must be installed over the insulation prior to the installation of approved underlayment and tiles.

1518.8.13 For mortar or adhesive set tile, no more than two tiles shall be loose per roofing square [100 square feet (9.3 m^2)]. No loose tile shall be adjacent to each other.

1518.9 Metal panels/shingles. Steel panels/shingles shall be a minimum of G-90 corrosion resistant, and shall be not less than 26 gage in thickness. Aluminum panels/shingles shall not be less than 0.025-inch (0.685 mm) thick. All other metal panel/shingle products shall be an equivalent weight. All metal panel/shingle assemblies shall be capable of withstanding foot traffic without damage to the metal panels/shingles. Metal panels/shingles shall have Product Approval for a complete metal system, which shall include the panel/shingle, underlayment and all related accessories to provide a complete waterproof system.

1518.9.1 All metal panels/shingles assemblies shall be tested in accordance with Section 1523, and TAS 125.

1518.9.2 The entire application method of all metal panel/shingle systems shall be detailed in the Product Approval and RAS 133, as applicable.

1518.9.3 Metal shingles may be applied as a recover over a single layer of asphaltic shingles or smooth surface roofing, providing the deck is solid sheathed and in compliance with the provisions of this code, the existing prepared roof covering is in compliance with provisions of this code and the entire metal shingle system is applied as set forth in the Product Approval.

1518.9.4 Metal panel/shingle systems shall not extend more than 1 inch (25 mm) beyond the roof eave.

1518.9.5 All intersections shall be flashed in metal as provided in Section 1517.6, RAS 111 and the roof assembly Product Approval.

1518.10 Wood shingles and shakes. All wood shingles and shakes shall be installed in accordance with RAS 130. Installation of all wood shingles and shakes shall be limited to a roof mean height of 33 feet (10 m), unless otherwise specifically noted in the Product Approval.

1518.10.1 All wood shingle/shake systems shall be tested in accordance with Section 1523.

SECTION 1519
HIGH-VELOCITY HURRICANE ZONES—ROOF COVERINGS WITH SLOPES LESS THAN 2:12

1519.1 General. All adhered roofing components shall be bonded to the various types of substrates in compliance with the requirements set forth in the roofing assembly Product Approval and the following minimum requirements. The authority having jurisdiction may adopt RAS 150 as the means of complying with the requirements listed in this section.

1519.2 All packaged asphalt shall have the following data printed on the carton wrapper:

1519.2.1 ASTM designation and type;

1519.2.2 Flash point as determined by ASTM D 92, *Flash and Fire Point by Cleveland Open Cup*; and

1519.2.3 Equiviscous temperature (EVT) at which the asphalt attains a viscosity of 125 centipoise (25 centipoise for coal tar) as determined by ASTM D 4402, *Viscosity Determinations of Unfilled Asphalt Using The Brookfield Thermoset Apparatus.*

1519.3 Asphalt types, as defined by ASTM D 312, shall be employed in all roofing assemblies. Application of asphalt shall be in compliance with Table 1519.3A and Table 1519.3B or as detailed in the roofing assembly Product Approval.

1519.4 Back nailing of interply sheets shall not be required when using ASTM D 312 Type IV asphalt on slopes less than 3:12.

1519.5 Mechanical attachment. All mechanically attached roofing components shall be attached to the various types of substrates in compliance with the requirements set forth in the roofing assembly Product Approval and the following minimum requirements.

1519.5.1 Base sheet attachment on wood decks. Nails shall be minimum 12 gage, annular ring shank nails having not less than 20 rings per inch; heads not less than $^3/_8$ inch (9.5 mm) in diameter; and lengths sufficient to penetrate through the thickness of plywood panel or wood plank decking not less than $^3/_{16}$ inch (5 mm), or to penetrate into a 1-inch (25.4 mm), or greater, thickness of lumber not less than 1 inch (25.4 mm). Nails shall be hot dipped; electro or mechanically galvanized to a thickness sufficient to resist corrosion in compliance with Appendix E of TAS 114. All nails shall have Product Approval. All nail cartons or carton labels shall be labeled to note compliance with the corrosion resistance requirements. No roofing material shall be fully or partially adhered, unless otherwise noted in the roof assembly Product Approval directly to a nailable deck.

1519.5.1.1 Such fasteners shall be applied through "tin caps" not less than $1^5/_8$ inches (43 mm) and not more than 2 inches (51 mm) in diameter and of not less than 32 gage [0.010-inch (.25 mm)] sheet metal. All tin caps and cap nails shall be listed by the certification agency.

1519.5.1.2 Prefabricated fastener systems complying with Section 1519.5.1 and Section 1519.5.1.1 may be used, provided they are Product Approved.

1519.5.1.3 Spacing of such fasteners shall be in compliance with patterns set forth in the roofing assembly Product Approval.

1519.5.2 Where the architectural appearance of the underside is to be preserved, a base sheet may be secured in an alternate method of attachment prepared, signed, and sealed by a Florida-registered architect or engineer, or in buildings where the mean roof height does not exceed 15 feet (4.6 m), a base sheet may be secured with $1^1/_4$-inch (32 mm) fasteners on supporting members, with a minimum of $^1/_2$-inch (12.7 mm) fasteners between the supporting members, all of which shall be secured through tin caps and nailed 6 inches (152 mm) o.c. in all directions.

1519.5.3 Lightweight insulating concrete. All lightweight insulated concrete shall be vented per roofing system manufacturer recommendations.

1519.5.3.1 Lightweight concrete shall not be applied over an existing roof deck unless the supporting structure has been approved as adequate to sustain the added weight. Calculations verifying the adequacy of the existing structure to sustain the added weight shall be prepared, signed, sealed and dated by a Florida-registered architect or engineer, who is proficient in structural design, and submitted with the uniform roofing permit application.

1519.5.4 Other nailable decks. The mechanical attachment of roofing components to other nailable decks shall be governed by the roofing assembly Product Approval.

1519.6 Cast-in-place and precast structural concrete decks. Cast-in-place and precast structural concrete decks are considered non-nailable. Concrete decks shall be clean, dry and fully primed with ASTM D 41 or ASTM D 43, as required, primer applied at a rate of not less than 1 gallon (3.8 L) per square. Hot asphalt or cold adhesive shall not be applied until the primer has fully dried.

1519.6.1 In hot mopped applications over precast panels, a minimum of 12-inch (305 mm) wide strips of roofing felt or modified bitumen shall be applied to all panel joints. Said strips shall be bonded to the panel joints with asphalt, approved mastic or approved cold applied adhesive or shall be torched to a primed surface.

1519.7 Steel decks. Steel decks shall be covered with a roof insulation panel having its own Product Approval and listed in the roofing assembly product approval. Insulation panels shall be mechanically fastened in compliance with the mechanical attachment patterns listed in the roofing assembly Product Approval and in accordance with the provisions of RAS 117.

1519.7.1 If the deck thickness on an existing steel deck is less than 22 gage, a field fastener withdrawal resistance test shall be conducted in compliance with TAS 105, to confirm compliance with the wind load requirements of Chapter 16 (High-Velocity Hurricane Zones). Test results shall be submitted with the uniform roofing permit application for review prior to issuance of the roofing permit. The field fastener withdrawal resistance test shall be carried out by an approved testing laboratory.

1519.7.2 Steel decks shall be welded or mechanically attached to the structure in compliance with the design pressure requirements set forth in Chapter 16 (High-Velocity Hurricane Zones).

1519.7.3 Composite wood and insulation panels shall be mechanically attached to steel decks in compliance with the attachment requirements enumerated in the insulation roofing component Product Approval. The composite wood insulation panel shall be in compliance with the minimum sheathing requirements of this code.

1519.8 Flashing. All flashing shall be installed according to the roof assembly manufacturer's published details and literature and in accordance with RAS 111.

1519.9 Valleys. Valleys in BUR shall be installed according to the roof assembly manufacturer's published literature for high wind areas and in compliance with the applicable detail described in the Product Approval.

1519.10 Parapet walls. All parapet wall details shall be installed in accordance with the roofing system product approval, manufacturer's published details and literature and in accordance with approved methods detailed in RAS 111.

1519.11 Insulation. Roof insulation shall be applied in compliance with the roofing system Product Approval and RAS 117.

1519.12 Surfacing. Roofing assemblies shall be surfaced in compliance with the Product Approval. Surfacing shall be in sufficient quantity to comply with the required fire classification. Aggregate surfacing shall not be used on slopes greater than 3:12. Aggregate shall be embedded in a flood coat of bitumen applied over a prepared top ply.

1519.12.1 On slopes of 3:12 or less, not less than 400 pound (182 kg) of roofing gravel or 300 pounds (145 kg) of slag per square shall be applied. A minimum of 50 percent of the total aggregate shall be embedded in the flood coat of bitumen. Aggregate shall be dry and free from dirt and shall be in compliance with the sizing requirements set forth in ASTM D 1863. A building official may request a test to confirm compliance with these requirements.

1519.12.2 On inclines greater than 3:12, a smooth surface coating shall be applied.

1519.12.3 Mineral surfaced cap sheet applications shall not require any additional surfacing unless required with the particular assembly for a fire classification.

1519.12.4 All smooth surface applications shall be coated with an aluminized or emulsion coating, having a valid and current Product Approval and shall be in compliance with the application instructions in said Product Approval. Coating quantity shall be in compliance with the required fire rating classification for the structure.

1519.13 Attachment of metal termination. All edge metal and terminations shall be installed according to manufacturer's published literature, provided it meets the minimum requirements as set for in RAS 111 and Chapter 16 (High-Velocity Hurricane Zones).

1519.14 Expansion joints. Expansion joint covers and expansion joint components shall be constructed and installed in accordance with the roofing assembly manufacturer's published literature.

1519.15 Venting roofing assemblies. All roof assemblies shall be applied to a dry substrate. Vapor retarders shall be installed, where applicable, to reduce moisture vapor flow into insulation from the warm, humid building interior, leading to internal condensation. Vents shall be installed to assist in the expulsion of moisture vapor where such vapor may enter the roofing assembly or moisture, as defined in Section 1521.12. Venting units shall not allow vapor to enter the roofing assembly when the high vapor pressure side is above the roofing membrane.

1519.16 Waterproofing. Waterproofing systems may be installed in lieu of an approved roof system over sloped or hoizontal decks specifically designed for pedestrian and/or vehicular traffic, whether the deck is above occupied or unoccupied space. In new construction the minimum deck slope shall be $^1/_4$:12.

1519.16.1 The waterproofing system must possess a current and valid product approval.

1519.16.2 If an overburden or wearing surface is not to be installed, the waterproofing system must be approved by the manufacturer for use in vehicular and/or pedestrian traffic locations.

1519.16.3 The waterproofing assembly must possess a Class A, Class B or Class C fire rating as required herein.

1519.16.4 If any portion of the waterproofing membrane is to remain exposed, the waterproofing system shall be ultra-violet resistant.

1519.16.5 Flashings must be installed in accordance with the waterproofing manufacturer's published specifications and in compliance with the material and attachment standards of RAS 111.

1519.16.6 The waterproofing system shall be flood tested in accordance with ASTM D 5957.

1519.16.6.1 The flood test shall take place after installation of the waterproofing membrane and prior to the installation of any above membrane components, wearing surface or overburden.

1519.16.6.2 An approved testing lab shall provide written verification to the building official confirming that the flood test was performed along with the results, prior to final inspection.

SECTION 1520
HIGH-VELOCITY HURRICANE ZONES—ROOF INSULATION

1520.1 General. All roof insulation shall have a product approval as an approved roofing component for use in roofing assemblies. All insulation shall be tested for physical properties in accordance with TAS 110.

1520.2 Foam plastic. Foam plastic roof insulation shall conform to the material and insulation requirements of Chapter 26.

1520.2.1 Foam insulation panels shall be overlaid with a perlite, fiberglass, wood fiber or mineral wool overlay unless specifically stated to the contrary in the roof assembly Product Approval.

1520.3 Cellulose fiberboard. Cellulosic fiberboard roof insulation requirements shall conform to the materials and insulation requirements of Chapter 23.

1520.4 Insulation fasteners, membrane fasteners and stress plates. All insulation fasteners, membrane fasteners and stress plates shall have a roof component Product Approval, and shall be tested in compliance with RAS 117 Appendixes A, B and C, and TAS 110 and TAS 114, Appendix E, Section 3 (DIN 50018), for corrosion resistance.

1520.5 Application. Roof insulation shall be applied in strict compliance with the application methods detailed in the roof assembly Product Approval and with the requirements set forth in RAS 117.

1520.5.1 Roof insulation, either on the ground or on the roof top, shall be kept dry. The building official shall instruct the removal of the insulation from the job when elevated moisture levels are found in the insulation or where panels cannot achieve 85-percent adhesion.

1520.5.2 When applied in hot asphalt or cold adhesive, no insulation panel's dimension shall be greater than 4 feet (1219 mm).

1520.5.3 Strip or spot mopping of insulation panels shall be used as an application method only when approved in the roof assembly Product Approval.

1520.5.4 Where more than one layer of insulation is applied, joints between layers shall be staggered.

1520.5.5 Application in approved cold adhesive shall be as detailed in the Product Approval and shall be in compliance with the required fire classification.

1520.5.6 Nail boards or composite panels with a nailable surface may be applied to sloped decks for the application of prepared roof covering or metal roofing systems, providing that the nailing surface is minimum $^{15}/_{32}$-inch (12 mm) exterior grade plywood sheathing, and has been attached to the deck with approved fastening assemblies in accordance with the windload requirements of Chapter 16 (High-Velocity Hurricane Zones). Composite panels shall be gapped a minimum of $^{1}/_{8}$ inch (3.2 mm) to allow for expansion of the sheathing panel.

1520.5.7 Suitable nailable decks installed over rigid board roof insulation in buildings of mean roof height of 35 feet (10.7 m) or less, shall be a minimum of $^{15}/_{32}$-inch (12 mm) exterior grade plywood sheathing. These decks shall be fastened to every structural roof frame member or to the existing deck under the insulation, at intervals of not more than 24 inches (610 mm) apart, with a minimum #12 approved insulation fastener spaced at a maximum of 12 inches (305 mm) apart in one direction with a minimum penetration of $1^{1}/_{2}$ inches (38 mm) into the structural member or deck. In these cases the maximum thickness of the rigid insulation board shall not exceed 2 inches (51 mm). An alternate method of attachment may be proposed, provided it is in compliance with Chapter 16 (High-Velocity Hurricane Zones), and it is prepared, signed and sealed by a Florida-registered architect or a Florida professional engineer, which architect or engineer shall be proficient in structural design.

1520.5.8 Mechanical attachment of insulation panels at uneven areas shall be acceptable. Hollowing, cutting or scoring of insulation panels to provide contact shall not be acceptable.

SECTION 1521
HIGH-VELOCITY HURRICANE ZONES—REROOFING

1521.1 General. Materials and methods of application used for recovering or replacing an existing roof covering, system or assembly shall comply with the requirements set forth in Sections 1512 through 1525.

1521.2 Repairs shall be carried out with roofing components as defined in this chapter having a Product Approval.

1521.3 Repairs shall be carried out in such a manner as to not create additional ponding water.

1521.4 Not more than 25 percent of the total roof area or roof section of any existing building or structure shall be repaired, replaced or recovered in any 12-month period unless the entire existing roofing system or roof section is replaced to conform to requirements of this code.

1521.5 A roofing system shall not be applied over an existing roof or over an existing roof deck where the roof sheathing has not been fastened in compliance with this code or where the roof sheathing will not permit effective fastening or where sheathing is water soaked or deteriorated so that effective attachment is not possible. All areas of deteriorated sheathing shall be removed and replaced. The building official shall not be required to inspect the renailing of the sheathing under this section.

1521.6 Structural concrete decks shall be allowed to dry or shall be dried prior to application of an ASTM D 41 or ASTM D 43, as required, or roofing system proprietary primer where the base sheet or base insulation layer is bonded to the concrete deck.

1521.7 On lightweight concrete, gypsum and cementitious wood fiber roof decks a field fastener withdrawal resistance test, in compliance with TAS 105, shall be carried out to confirm compliance with wind load requirements of Chapter 16 (High-Velocity Hurricane Zones).

1521.7.1 If the tested fasteners exhibit a minimum characteristic resistance force less than 80 percent than that listed in the Product Approval, a structural engineer shall examine the deck's integrity and provide a proposed attachment specification. Such specification shall be submitted with the uniform roofing permit application for review and approval by the building official prior to the issuance of a roofing permit. Calculations for the attachment of the anchor sheet/base sheet or insulation over these deck types, shall be in compliance with RAS 117.

1521.8 Steel decks shall be examined prior to recover for indication of corrosion. Any corrosion shall be treated with a rust inhibitor, providing the field fastener withdrawal resistance values of the proposed mechanical fasteners comply with the requirements of Chapter 16 (High-Velocity Hurricane Zone) of this code. All steel decks less than 22 gage shall be field tested for fastener withdrawal resistance for compliance with Chapter 16 (High-Velocity Hurricane Zones) prior to application of a new roofing system. Test results shall be submitted with the uniform roofing permit application.

1521.9 One additional roofing system may be applied over an original roofing assembly, providing the existing roofing assembly complies with the requirements of Section 1521.

1521.10 If the recover roofing assembly is to be bonded to an existing roofing membrane, the existing roofing membrane shall be tested in compliance with TAS 124 for uplift resistance. The existing roofing membrane shall resist the design pressures calculated under Chapter 16 (High-Velocity Hurricane Zones) of this code. Test results shall be submitted with the uniform roofing permit application.

1521.11 If the recover roofing assembly is mechanically attached through either a base sheet or insulation layer, the attachment assembly shall be field tested for fastener withdrawal resistance, in compliance with TAS 105, and laboratory tested for pull-over resistance to insure compliance with wind uplift requirements set forth in Chapter 16 (High-Velocity Hurricane Zones) of this code. Test results shall be submitted with the uniform roofing permit application. Recover roofing assembly anchor sheet or base sheet shall not be mechanically fastened directly to existing gravel roof unless all gravel is completely removed.

1521.12 Moisture content of the existing roofing assembly to be covered by a new roofing system shall not exceed 5 percent by weight in the roofing membrane and 8 percent by weight in commercially manufactured rigid board roof insulation as verified by moisture survey performed in accordance with TAS 126. Test results shall be submitted with the Uniform Roofing Permit Application.Testing for moisture content shall not be required for existing lightweight insulating concrete, gypsum, and cementious wood fiber roof decks. All existing lightweight insulating concrete, gypsum and cementious wood fiber roof decks shall be tested per Section 1521.7 to confirm compliance with wind load requirements of Chapter 16 (High-Velocity Hurricane Zones).

1521.13 Prior to starting the work the contractor has the responsibility of notifying the owner, by means of the roofing permit and required owners notification for roofing considerations herein, of any possibility of ponding water and recommend a structural review if ponding water is a possibility.

1521.14 If the new roofing system is to be bonded to the existing roof surface, the surface shall be free of all loose gravel, dirt and silt and dry prior to commencement of the roofing application. All blisters shall be cut and repaired prior to roofing application.

1521.14.1 If the existing roof surface has gravel embedded in hot asphalt, all loose gravel shall be removed together with any dirt and silt. The dry membrane surface shall be primed with ASTM D 41 primer or proprietary roofing system primer and allowed to dry thoroughly. A flood coat of ASTM D 312, type III or IV asphalt shall be applied to sufficient depth to cover the remaining embedded gravel. The prepared substrate shall be suitable for application of a new insulation layer only.

1521.14.2 In the case of existing coal tar assemblies, the existing roof surface shall be primed with ASTM D 43 primer or covered with a mechanically attached separation board prior to application of a new coal tar assembly. If an existing coal tar assembly is to be covered with an asphalt applied roofing system, only the separation board is acceptable. The attachment of the entire assembly, including the separation board, shall meet the design pressure requirements set forth in Chapter 16 (High-Velocity Hurricane Zones).

1521.14.3 Insulation shall have a Product Approval as a roofing component approved for use as a part of the roofing assembly. The insulation panels shall be bonded or mechanically attached in compliance with the Product Approval and RAS 117.

1521.15 Where an existing sloped roof is sheathed with spaced sheathing, any existing prepared roof covering shall be removed. New sheathing shall be applied in compliance with Chapter 16 (High-Velocity Hurricane Zones), or open spacing shall be filled with dimensional lumber to create solid wood sheathing providing the spaced sheathing is in compliance with this code. Spaced sheathing is approved for use with wood shakes and wood shingles only.

1521.16 No recover application shall take place over existing wood shingles, shakes, slate, tile or metal shingles.

1521.17 Asphaltic shingle assemblies may be applied over one existing layer of asphaltic shingles having not more than $^{1}/_{8}$-inch (3.2 mm) difference in level in the existing shingle material. Recover over an existing shingle system shall be with a product having a Product Approval as prepared roof covering, in strict compliance with the application method detailed in the product approval.

1521.18 Sprayed polyurethane foam (PUF) and elastomeric coating systems may be applied over existing roofing assemblies providing the PUF system has obtained a product approval, the deck has been prepared in compliance with the product approval and this code, the application is in strict compliance with the foam manufacturer's published application instructions for the environmental conditions at the time of application and post-application inspections conform to RAS 109.

1521.18.1 No PUF and/or elastomeric coating systems shall be applied over existing composition shingles.

1521.18.2 Upon completion of a PUF system, an inspection of the system shall be carried out by an authorized representative of the coating manufacturer. A certification shall be furnished to the building official within 30 days of completion, confirming that the quality control tests detailed in the PUF system Product Approval have been carried out with satisfactory results.

1521.18.3 Should a PUF system have inadequate adhesion to meet the design pressures, as set forth in Chapter 16 (High-Velocity Hurricane Zones), the roofing system shall be removed and replaced with a roofing system tested to adequate adhesion. An additional inspection shall be required once the roofing system has been replaced. A field adhesion test may be requested by the building official during the application or at the completion of the project to confirm adequate adhesion.

1521.18.4 The PUF system shall comply with Section 1521.

1521.18.5 All PUF systems shall be installed by licensed roofing contractors holding an applicator's certificate from the manufacturer holding the product approval for the PUF system.

1521.19 Roof coverings or roofing components, such as tile, slate or similar, shall not be applied over an existing roofing system.

1521.20 Lightweight insulated concrete shall not be applied over an existing roofing system unless the existing roofing assembly is verified to be adequate to accept the new lightweight insulating concrete and is in compliance with the testing required herein.

1521.21 Existing ventilation. Ridge ventilation is recommended whenever possible to create airflow entering the soffit and exiting the ridge. Ridge ventilation shall not be installed without adequate soffit ventilation to draw outside air through the ridge void. When recovering, repairing or reroofing, the existing amount of attic ventilation shall not be reduced.

Exception: Attic spaces designed by a Florida-licensed engineer or registered architect to eliminate the attic venting.

SECTION 1522 HIGH-VELOCITY HURRICANE ZONES— ROOFTOP STRUCTURES AND COMPONENTS

1522.1 Rooftop structures. Rooftop structures shall be designed and constructed in accordance with the *Florida Building Code.*

1522.2 Rooftop mounted equipment. All rooftop equipment and supports shall be secured to the structure in compliance with the loading requirements of Chapter 16 (High-Velocity Hurricane Zones). The use of wood "sleepers" shall not be permitted.

Where equipment and appliances requiring access are installed on roofs or elevated structures at a height exceeding 16 feet (4877 mm), such access shall be provided by a permanent approved means of access, the extent of which shall be from grade or floor level to the equipment and appliances' level service space. Such access shall not require climbing over obstructions greater than 30 inches (762 mm) high or walking on roofs having a slope greater than 4 units vertical in 12 units horizontal (33-percent slope).

Permanent ladders installed to provide the required access shall comply with the following minimum design criteria:

1. The side railing shall extend above the parapet or roof edge not less than 30 inches (762 mm).
2. Ladders shall have rung spacing not to exceed 14 inches (356 mm) on center.
3. Ladders shall have a toe spacing not less than 6 inches (152 mm) deep.
4. There shall be a minimum of 18 inches (457 mm) between rails.
5. Rungs shall have a minimum 0.75-inch (19 mm) diameter and be capable of withstanding a 300-pound (136.1 kg) load.
6. Ladders over 30 feet (9144 mm) in height shall be provided with offset sections and landings capable of withstanding 100 pounds (488.2 kg/m^2) per square foot.
7. Ladders shall be protected against corrosion by approved means.

Catwalks installed to provide the required access shall be not less than 24 inches (610 mm) wide and shall have railings as required for service platforms.

Exception: This section shall not apply to Group R-3 occupancies. Minimum clearances below roof-mounted mechanical units shall be in accordance with Section 1509.7, *Florida Building Code, Building*.

1522.3 Machinery, piping, conduit, ductwork, signs and similar equipment may be mounted on roofs in compliance with the following:

1522.3.1 Permanently mounted rooftop equipment shall be installed to provide clearances, in accordance with Table 1522.3, to permit repairs, replacement and/or maintenance of the roofing system or any of its components.

TABLE 1522.3
ROOF MOUNTED EQUIPMENT HEIGHT REQUIREMENTS

WIDTH OF EQUIPMENT (in.)	HEIGHT OF LEGS (in.)
Up to 24	14
25 to 36	18
37 to 48	24
49 to 60	30
61 and wider	48

For SI: 1 inch = 25.4 mm.

1522.3.2 When reroofing, recovering, performing repair or roof maintenance, and where the roof top equipment is moved to properly execute such work, the minimum clearances of the said equipment support shall be in accordance with Table 1522.3.

1522.3.3 In buildings where the existing rooftop equipment, in the opinion of the building official, provides sufficient clearance to repair, recover, replace and/or maintain the roofing system or any of its components, such existing equipment need not comply with Table 1522.3.

1522.3.4 Electrical conduit, mechanical piping or any other service lines running on the roof shall be raised not less than 8 inches (203 mm) above the finished roof surface.

1522.3.5 Condensate lines shall not drain on the roofing system or any of its components. Condensate lines need not comply with the minimum clearance requirements.

SECTION 1523 HIGH-VELOCITY HURRICANE ZONES—TESTING

1523.1 Scope. This section defines the minimum testing requirements for substrates, roofing components, roofing systems and roofing assemblies. All roofing products shall be tested for physical properties, water-infiltration, uplift performance and fire resistance, as addressed within this code.

1523.1.1 Testing requirements for physical properties of all roofing products shall be as set forth in TAS 110.

1523.1.2 Testing requirements for fire resistance shall be in compliance with ASTM E 108 or UL 790.

1523.2 Application. Testing for substrates, roofing components, roofing systems and roofing assemblies shall comply with the provisions herein and those of *Florida Building Code, Building*, TAS and RAS listed in this code.

1523.3 Laboratory certification. All testing required by this code shall be performed by an approved testing laboratory.

1523.4 Margin of safety. A margin of safety of 2:1 shall be applied to all wind uplift resistance test results. All in-situ (on site) testing shall have an applied 1.45:1 margin of safety.

1523.5 Material labeling. All products shall be identified with the product approval number or logo; or the manufacturer's name or logo. ASTM standard roll goods shall be marked with a yellow line to identify the ASTM standard, or such other marking indicated in the Product Approval.

1523.5.1 All asphaltic shingles, tile products and metal roofing panels and clips shall be labeled on the underside with the *Florida Building Code, Building* insignia, or Product Approval number, or the wording "*Florida Building Code, Building* Product Approved," and manufacturer's initials or manufacturer's logo, or as specified in the manufacturer's Product Approval.

1523.6 Testing requirements.

1523.6.1 The certification agency, at its descretion, may carry out, observe or delegate the inspection and testing to an independent testing laboratory for any approved product. Should the manufacturer fail to meet the minimum requirements set forth in this code or specifically listed in the manufacturers product control approval, the certification agency shall have the authority to withdraw the approval until such time as the manufacturer complies with the approved physical properties. The certification agency shall have the authority, and shall charge the manufacturer for any cost incurred.

1523.6.2 Continuous roofing systems. All continuous roofing systems shall be tested in compliance with TAS 110 and TAS 114 in its entirety. All continuous roofing systems shall resist a minimum of 90 pounds per square foot (psf) (4309 Pa) tested wind uplift pressure resistance. Continuous roofing system testing requirements shall be as follows:

1523.6.2.1 Spray applied polyurethane foam. All spray applied polyurethane foam systems shall be tested in compliance to RAS 109 and TAS 110 and TAS 114.

1523.6.2.1.1 Physical properties testing for acrylic coatings used on spray applied polyurethane foam roofing assemblies shall be tested in compliance with ASTM D 6083 and federal specification TTC-555B, *Test Specification for Wind Driven Rain Infiltration Resistance.*

1523.6.3 Liquid applied roofing membranes systems. All liquid applied roofing membranes systems shall be tested in compliance with TAS 114, in addition to the physical properties testing requirements set forth in TAS 110, and fire resistance.

1523.6.3.1 For liquid applied acrylic roofing membrane assemblies, physical properties testing shall be in compliance with ASTM D 6083 and federal specification TTC-555B, Test Specification for Wind Driven Rain Infiltration Resistance.

1523.6.4 The building official may request that a quality control field uplift test be carried out on a continuous roofing system in compliance with test procedure TAS 124. Single-ply systems are not required to meet the deflection requirements established in the test protocol. The roofing system shall resist the design pressures as calculated in compliance with Chapter 16 (High-Velocity Hurricane Zones), and as established in TAS 124.

1523.6.4.1 Should a roofing system fail to meet a quality control field uplift test, the roofing contractor may propose to the building official an acceptable method of repair that is in compliance with the requirements of this code.

1523.6.5 Discontinuous roofing systems. All discontinuous roofing systems shall be tested in compliance with TAS 100 for wind-driven water infiltration resistance. Test specimens used for this test shall be constructed at the approved test facility. Testing requirements shall be as follows:

1523.6.5.1 Asphaltic shingle systems. All asphaltic shingle systems shall comply with the following requirements: TAS 100, TAS 107, ASTM D 3462 and ASTM D 3018. Asphaltic shingle systems shall have a quality control testing program by an approved independent listing agency having an unannounced follow-up visit. Follow-up test results shall be made available to the certification agency upon request.

1523.6.5.2 Clay and cement roof tiles. All roof tiles shall be tested in compliance with TAS 100. Physical properties testing for clay roof tiles shall be in compliance with ASTM D 1167. Physical properties testing for concrete roof tiles shall be in compliance with TAS 112. All approved roof tile manufacturers shall submit a quarterly TAS 112 Appendix A test report to the certification agency for review. All roof tiles shall resist a minimum wind uplift resistance as determined by Chapter 16 (High-Velocity Hurricane Zones) of this code and RAS 127. Clay and cement roof tile systems requirements are as follows:

1523.6.5.2.1 Underlayment. All underlayments used in discontinuous roof tile systems shall be tested in compliance with TAS 103 and TAS 104, unless otherwise specifically listed in the applicable RAS.

1523.6.5.2.2 Mortar or adhesive set roof tile systems. All mortar or adhesive set tile systems shall be tested for static uplift resistance in compliance with TAS 101, the results of which shall be listed in the system manufacturer's Product Approval.

1523.6.5.2.2.1 Additionally, roof tile system manufacturers may test for wind characteristics in compliance with TAS 108, provided the system is determined to be air permeable by testing in compliance with TAS 116; and the tiles meet the size criteria set forth in TAS 108. The result from this testing shall be an aerodynamic multiplier (λ) which represents the system's wind characteristics and shall be listed in the system manufacturer's Product Approval.

1523.6.5.2.2.2 Systems which are tested for wind characteristics, in compliance with TAS 108 as specified above, shall have the results of the TAS 101 testing treated as attachment resistance moment (Mf), which is representative of the tile bond's resistance to overturning moment, and the tile's restoring moment due to gravity (Mg). Such systems shall use the system's aerodynamic multiplier (l) in conjunction with the system's attachment resistance moment (Mf) and restoring moment due to gravity (Mg), as determined from the TAS 101 static uplift testing. These results shall be used in conjunction with the attachment calculations outlined in RAS 127 as a moment-based system. Such calculations shall be submitted to the building official for review.

1523.6.5.2.2.3 Systems that are not tested in compliance with TAS 108 as specified above shall have their product control approval based on the system's uplift minimum characteristic resistance force *(F')*, as determined from TAS 101 static uplift testing. These results shall be used in conjunction with the attachment calculations outlined in RAS 127 as an uplift-based system. Such calculations shall be submitted to the building official for review.

1523.6.5.2.2.4 Testing in accordance with TAS 106 shall be considered a product application quality control test to determine the general adhesion properties of the system.

1523.6.5.2.3 Mechanically fastened, rigid roofing systems. All mechanically attached set tile systems shall be tested for static uplift resistance in compliance with TAS 102 or TAS 102(A), the results of which shall be listed in the system manufacturer's NOA.

1523.6.5.2.3.1 Additionally, roof tile system manufacturers may test for wind characteristics in compliance with TAS 108, provided the system is determined to be air permeable by testing in compliance with TAS 116; and the tiles meet the size criteria set forth in TAS 108. The result from this testing shall be an aerodynamic multiplier (k) which represents the system's wind characteristics and shall be listed in the system manufacturer's Product Approval.

1523.6.5.2.3.2 Systems which are tested for wind characteristics in compliance with TAS 108 as specified above shall have the results of the TAS 102 or TAS 102(A) testing treated as an attachment resistance moment (Mf) which is representative of the rigid component's attachment resistance to an overturning moment, and the tile's restoring moment due to gravity (Mg). Such systems shall use the system's aerodynamic multiplier (k), in conjunction with the system's attachment resistance moment (Mf) and restoring moment due to gravity (Mg), as determined from the TAS 102 or TAS 102(A) static uplift testing. These results shall be used in conjunction with the attachment calculations outlined in RAS 127 as a moment-based system. Such calculations shall be submitted to the building official for review.

1523.6.5.2.3.3 Systems that are not tested in compliance with TAS 108 as specified above shall have their product control approval based on the system's uplift minimum characteristic resistance force (*F'*), as determined from TAS 102 or TAS 102(A) static uplift testing. These results shall be used in conjunction with the attachment calculations outlined in RAS 127 as an uplift-based system. Such calculations shall be submitted to the building official for review.

1523.6.5.2.3.4 TAS 106 quality control field static uplift testing shall be considered a product application quality control test to determine the general uplift resistance properties of the system.

1523.6.5.2.4 Metal shingles/panels. All metal roofing shall be tested in compliance with TAS 100. All metal roofing shall resist a minimum wind uplift resistance as determined by Chapter 16 (High-Velocity Hurricane Zones) for a roof slope of 9.5 degrees (0.0166 rad) and a roof mean height of 15 feet (4.6 m). All metal roofing systems testing requirements shall be as follows:

1523.6.5.2.4.1 All metal roofing shall be test in compliance with requirements set forth in TAS 110 and TAS 125, and shall be tested for wind driven rain infiltration resistance in compliance with TAS 100.

1523.6.5.2.4.2 Rigid metal shingle systems may be tested in an identical manner to nail-on or batten tile systems as set forth in this code.

1523.6.5.2.5 Wood shingles or shakes. All wood shingles and shakes shall be tested, as a system, for wind driven rain infiltration resistance in compliance with TAS 100. The same specimens as tested in TAS 100 shall be tested for pull-through tear resistance, and such values shall be listed in the manufacturer's Product Approval.

1523.6.5.2.6 Fiber cement shingle or tile panels. All fiber cement shingles or tiles shall resist a minimum wind uplift resistance as determined by Chapter 16 (High-Velocity Hurricane Zones) for a roof slope of 9.5 degrees (0.0166 rad) and a roof mean height of 15 feet (4.6 m). All fiber cement shingle or tiles shall be tested in compliance with the following requirements. Wind driven water resistance in compliance with TAS

100, physical properties in compliance with TAS 110, TAS 135 and uplift resistance.

1523.6.5.2.6.1 Additionally, fiber cement tile system manufacturers may test for wind characteristics in compliance with TAS 108, provided the system is determined to be air permeable by testing in compliance with TAS 116 and the tiles meet the size criteria set forth in TAS 108. The result from this testing shall be an aerodynamic multiplier (k) which represents the system's wind characteristics and shall be listed in the system manufacturer's Product Approval.

1523.6.5.2.6.2 Systems which are tested for wind characteristics in compliance with TAS 108 as specified above shall have the results of the TAS 102 or TAS 102(A) testing treated as an attachment resistance moment (Mf) which is representative of the rigid component's attachment resistance to an overturning moment, and the tile's restoring moment due to gravity (Mg). Such systems shall use the system's aerodynamic multiplier (λ), in conjunction with the system's attachment resistance moment (Mf) and restoring moment due to gravity (Mg), as determined from the TAS 102 or TAS 102(A) static uplift testing. These results shall be used in conjunction with the attachment calculations outlined in RAS 127 as a moment-based system. Such calculations shall be submitted to the building official for review.

1523.6.5.2.6.3 Systems that are not tested in compliance with TAS 108 as specified above shall have their product approval based on the system's uplift minimum characteristic resistance force (*F'*), as determined from TAS 102 or TAS 102(A) static uplift testing. These results shall be used in conjunction with the attachment calculations outlined in RAS 115 as an uplift-based system. Such calculations shall be submitted to the building official for review.

1523.6.5.2.6.4 TAS 106 quality control field static uplift testing shall be considered a product application quality control test to determine the general uplift resistance properties of the system.

1523.6.5.2.7 Quarry roof slate. All quarry roof slate shall be tested in compliance with TAS 100 and TAS 110.

1523.6.5.2.8 Roof board insulation. All roof board insulation shall be tested for physical properties as set forth in Section 7 of TAS 110.

1523.6.5.2.9 Insulation fasteners, membrane fasteners and stress plates. All insulation fasteners, membrane fasteners and stress plates shall be tested in compliance with RAS 117 Appendices A, B and C, and TAS 110 and TAS 114, Appendix E, Section 3, (DIN 50018), for corrosion resistance.

1523.6.5.2.10 Roofing nails and tin-caps. All roofing nails and tin-caps shall be tested for corrosion resistance in compliance with TAS 114, Appendix E, Section 2 (ASTM G 85).

1523.6.5.2.11 Roof tile nails or fasteners. All roof tile nails or fasteners, except those made of copper, monel, aluminum or stainless steel, shall be tested for corrosion in compliance with TAS 114, Appendix E, Section 2 (ASTM G 85), for salt spray for 1000 hr.

1523.6.5.2.11.1 Tile fasteners used in coastal building zones, as defined in Chapter 16 (High-Velocity Hurricane Zone), shall be copper, monel, aluminum or stainless steel.

1523.6.5.2.12 Roofing adhesives, mastics and coatings. All roofing adhesives, mastics and coatings shall be tested in compliance with TAS 110 and TAS 121.

1523.6.5.2.12.1 All roofing adhesives, mastics and coatings shall have a quality control testing program by an approved independent listing agency having unannounced follow-up visits.

1523.6.5.2.12.2 Acrylic roof coatings shall be tested for physical properties in compliance with ASTM D 6083.

1523.6.5.2.13 Ridge vents of metal, plastic or composition material. All ridge vents shall be tested in compliance with TAS 100(A) for for wind driven water infiltration. All ridge ventilators shall be restricted to roof mean height as tested in compliance with TAS 100(A), and shall be listed in the system manufacturer's Product Approval.

1523.6.5.2.13.1 All plastic ridge ventilators shall be tested for physical properties as set forth in TAS 110 and Chapter 26 of this code.

1523.6.5.2.13.2 All plastic ridge ventilator manufacturers shall have an unannounced follow-up quality control program from an approved listing agency. Follow-up test results shall be made available to the certification agency upon request.

1523.6.5.2.14 Edge metal, flashings, and coping. All edge metal, flashing and copings, not specifically described in RAS 111, shall be tested in complianced with TAS 110, TAS 111(A), TAS 111(B) or TAS 111(C), respectively.

1523.6.5.2.15 Roof tile pre-mixed bagged mortar. All premixed roof tile mortar shall comply with the requirements set forth in TAS 110 and TAS 123, and shall have a quality control testing program by an approved independent listing agency having unannounced follow-up visits. Follow-up test results shall be made available to the certification agency upon request.

1523.6.5.2.16 Roof tile adhesive used in repair or supplemental tile attachment. All roof tile adhesive used in repair or supplemental tile attachment shall comply with the requirements set forth in TAS 110 and TAS 123(A).

1523.6.5.2.17 Roof tile adhesive used in adhesive set tiles systems. All roof tile adhesive used in adhesive set tile systems shall comply with the requirements set forth in TAS 110 and TAS 123. Physical properties shall be as follows:

1523.6.5.2.17.1 Tested for compressive strength in compliance with ASTM D 1621 with a minimum strength of 18 psi (121 kPa) parallel to rise, and 12 psi (82.7 kPa) perpendicular to rise.

1523.6.5.2.17.2 Tested for density in compliance with ASTM D 1622 with a minimum density of 1.6 lb/ft^3 (25.6 kg/m^3).

1523.6.5.2.17.3 Tested for tensile strength in compliance with ASTM D 1623 with a minimum requirement of 28 psi (193 kPa) parallel to rise.

1523.6.5.2.17.4 Tested for dimensional stability taken from a free rise sample specimen. Tested in compliance with ASTM D 2126 with a maximum volume change of +0.07 percent volume change at -40ºF (-40ºC) for two weeks; and +6.0 percent volume change at 158ºF (70ºC) and 100 percent RH for two weeks.

1523.6.5.2.17.5 Tested in compliance with ASTM D 2856 from a free rise sample specimen with a minimum requirement for 85 percent.

1523.6.5.2.17.6 Tested for water absorption in compliance with ASTM D 2842 with a maximum requirement of 10 percent.

1523.6.5.2.17.7 Tested in compliance with ASTM E 96 for moisture vapor transmission for a maximum of 3.1 perms.

SECTION 1524
HIGH-VELOCITY HURRICANE ZONES—REQUIRED OWNERS NOTIFICATION FOR ROOFING CONSIDERATIONS

1524.1 Scope. As it pertains to this section, it is the responsibility of the roofing contractor to provide the owner with the required roofing permit, and to explain to the owner the content of this section. The provisions of Chapter 15 of the *Florida Building Code, Building* govern the minimum requirements and standards of the industry for roofing system installations. Additionally, the following items should be addressed as part of the agreement between the owner and the contractor. The owner's initial in the designated space indicates that the item has been explained.

1. **Aesthetics-workmanship:** The workmanship provisions of Chapter 15 (High-Velocity Hurricane Zone) are for the purpose of providing that the roofing system meets the wind resistance and water intrusion performance standards. Aesthetics (appearance) are not a consideration with respect to workmanship provisions. Aesthetic issues such as color or architectural appearance, that are not part of a zoning code, should be addressed as part of the agreement between the owner and the contractor.
2. **Renailing wood decks:** When replacing roofing, the existing wood roof deck may have to be renailed in accordance with the current provisions of Chapter 16 (High-Velocity Hurricane Zones) of the *Florida Building Code, Building*. (The roof deck is usually concealed prior to removing the existing roof system.)
3. **Common roofs:** Common roofs are those which have no visible delineation between neighboring units (i.e., townhouses, condominiums, etc.). In buildings with common roofs, the roofing contractor and/or owner should notify the occupants of adjacent units of roofing work to be performed.
4. **Exposed ceilings:** Exposed, open beam ceilings are where the underside of the roof decking can be viewed from below. The owner may wish to maintain the architectural appearance; therefore, roofing nail penetrations of the underside of the decking may not be acceptable. The owner provides the option of maintaining this appearance.
5. **Ponding water:** The current roof system and/or deck of the building may not drain well and may cause water to pond (accumulate) in low-lying areas of the roof. Ponding can be an indication of structural distress and may require the review of a professional structural engineer. Ponding may shorten the life expectancy and performance of the new roofing system. Ponding conditions may not be evident until the original roofing system is removed. Ponding conditions should be corrected.
6. **Overflow scuppers (wall outlets):** It is required that rainwater flow off so that the roof is not overloaded from a buildup of water. Perimeter/edge walls or other roof extensions may block this discharge if overflow scuppers (wall outlets) are not provided. It may be necessary to install overflow scuppers in accordance with the requirements of: Chapter 15 and 16 herein and the *Florida Building Code, Plumbing.*
7. **Ventilation:** Most roof structures should have some ability to vent natural airflow through the interior of the structural assembly (the building itself). The existing amount of attic ventilation shall not be reduced.

Exception: Attic spaces, designed by a Florida-licensed engineer or registered architect to eliminate the attic venting, venting shall not be required.

______________________	_____	______________________
Owner's/Agent's Signature	Date	Contractor's Signature

SECTION 1525
HIGH-VELOCITY HURRICANE ZONES UNIFORM PERMIT APPLICATION

Florida Building Code Edition 2004
High-Velocity Hurricane Zone Uniform Permit Application Form.

INSTRUCTION PAGE

COMPLETE THE NECESSARY SECTIONS OF THE UNIFORM ROOFING PERMIT APPLICATION FORM AND ATTACH THE REQUIRED DOCUMENTS AS NOTED BELOW:

Roof System	Required Sections of the Permit Application Form	Attachments Required See List Below
Low Slope Application	A,B,C	1,2,3,4,5,6,7
Prescriptive BUR-RAS 150	A,B,C	4,5,6,7
Asphaltic Shingles	A,B,D	1,2,4,5,6,7
Concrete or Clay Tile	A,B,D,E	1,2,3,4,5,6,7
Metal Roofs	A,B,D	1,2,3,4,5,6,7
Wood Shingles and Shakes	A,B,D	1,2,4,5,6,7
Other	As Applicable	1,2,3,4,5,6,7

ATTACHMENTS REQUIRED:

1.	Fire Directory Listing Page
2.	From Product Approval: Front Page Specific System Description Specific System Limitations General Limitations Applicable Detail Drawings
3.	Design Calculations per Chapter 16, or If Applicable, RAS 127 or RAS 128
4.	Other Component of Product Approval
5.	Municipal Permit Application
6.	Owners Notification for Roofing Considerations (Reroofing Only)
7.	Any Required Roof Testing/Calculation Documentation

Florida Building Code Edition 2004

High-Velocity Hurricane Zone Uniform Permit Application Form.

Section A (General Information)

Master Permit No.__________________________________ Process No. __________________________

Contractor's Name ____

Job Address____

ROOF CATEGORY

☐ Low Slope ☐ Mechanically Fastened Tile ☐ Mortar/Adhesive Set Tile

☐ Asphaltic Shingles ☐ Metal Panel/Shingles ☐ Wood Shingles/Shakes

☐ Prescriptive BUR-RAS 150

ROOF TYPE

☐ New Roof ☐ Reroofing ☐ Recovering ☐ Repair ☐ Maintenance

ROOF SYSTEM INFORMATION

Low Slope Roof Area (SF) Steep Sloped Roof Area (SF) Total (SF)

Section B (Roof Plan)

Sketch Roof Plan: Illustrate all levels and sections, roof drains, scuppers, overflow scuppers and overflow drains. Include dimensions of sections and levels, clearly identify dimensions of elevated pressure zones and location of parapets.

Florida Building Code Edition 2004

High-Velocity Hurricane Zone Uniform Permit Application Form.

Section C (Low Slope Application)
Fill in specific roof assembly components and identify manufacturer (If a component is not used, identify as "NA")

System Manufacturer:______________________________

Product Approval No.:______________________________

Design Wind Pressures, From RAS 128 or Calculations:

Pmax1:________ **Pmax2:**_________ **Pmax3:**_________

Max. Design Pressure, from the specific Product Approval system:______________________________

Deck:

Type:______________________________

Gauge/Thickness:______________________________

Slope:______________________________

Anchor/Base Sheet & No. of Ply(s):__________________

Anchor/Base Sheet Fastener/Bonding Material:
____

Insulation Base Layer: ____________________________

Base Insulation Size and Thickness: ________________

Base Insulation Fastener/Bonding Material:
____

Top Insulation Layer: ______________________________

Top Insulation Size and Thickness: _________________

Top Insulation Fastener/Bonding Material:
____

Base Sheet(s) & No. of Ply(s): ___________________

Base Sheet Fastener/Bonding Material:
____

Ply Sheet(s) & No. of Ply(s): _____________________

Ply Sheet Fastener/Bonding Material:
____

Top Ply: ______________________________________

Top Ply Fastener/Bonding Material:
____

Surfacing: ______________________________________

Fastener Spacing for Anchor/Base Sheet Attachment:

Field: ____" oc @ Lap, # Rows ____ @ ____" oc

Perimeter: ____" oc @ Lap, # Rows ___ @ ____" oc

Corner: ____" oc @ Lap, # Rows ____ @ ____" oc

Number of Fasteners Per Insulation Board:

Field _____ Perimeter _____ Corner _____

Illustrate Components Noted and Details as Applicable:
Woodblocking, Gutter, Edge Termination, Stripping, Flashing, Continuous Cleat, Cant Strip, Base Flashing, Counter-Flashing, Coping, Etc.
Indicate: Mean Roof Height, Parapet Height, Height of Base Flashing, Component Material, Material Thickness, Fastener Type, Fastener Spacing or Submit

Florida Building Code Edition 2004

High-Velocity Hurricane Zone Uniform Permit Application Form.

Section D (Steep Sloped Roof System)

Roof System Manufacturer: ____

Notice of Acceptance Number: _____________________________________

Minimum Design Wind Pressures, If Applicable (From RAS 127 or Calculations):
P1: ___________ **P2:** __________ **P3:** __________

Maximum Design Pressure (From the Product Approval Specific System):
____

Steep Sloped Roof System Description

Deck Type: ____________

Type Underlayment: ____________

Roof Slope: ______: 12

Insulation: ____________

Fire Barrier: ____________

Ridge Ventilation? ____________

Fastener Type & Spacing: ____________

Adhesive Type: ____________

Type Cap Sheet: ____________

Mean Roof Height: ____________

Roof Covering: ____________

Type & Size Drip Edge: ____________

Florida Building Code Edition 2004

High-Velocity Hurricane Zone Uniform Permit Application Form.

Section E (Tile Calculations)

For Moment based tile systems, choose either Method 1 or 2. Compare the values for M_r with the values from M_f. If the M_f values are greater than or equal to the M_r values, for each area of the roof, then the tile attachment method is acceptable.

Method 1 "Moment Based Tile Calculations Per RAS 127"

(P_1: _______ × λ _______ =_______) - Mg: _______ = M_{r1} _______ Product Approval M_f _______

(P_2: _______ × λ _______ =_______) - Mg: _______ = M_{r2} _______ Product Approval M_f _______

(P_3: _______ × λ _______ =_______) - Mg: _______ = M_{r3} _______ Product Approval M_f _______

Method 2 "Simplified Tile Calculations Per Table Below"

Required Moment of Resistance (Mr) From Table Below _______ Product Approval M_f _______

M_r required Moment Resistance*					
Mean Roof Height → Roof Slope ↓	15'	20'	25'	30'	40'
2:12	34.4	36.5	38.2	39.7	42.2
3:12	32.2	34.4	36.0	37.4	39.8
4:12	30.4	32.2	33.8	35.1	37.3
5:12	28.4	30.1	31.6	32.8	34.9
6:12	26.4	28.0	29.4	30.5	32.4
7:12	24.4	25.9	27.1	28.2	30.0

*Must be used in conjunction with a list of moment based tile systems endorsed by the Broward County Board of Rules and Appeals.

For Uplift based tile systems use Method 3. Compared the values for F' with the values for Fr. If the F' values are greater than or equal to the Fr values, for each area of the roof, then the tile attachment method is acceptable.

Method 3 "Moment Based Tile Calculations Per RAS 127"

(P_1: ______ × L ______ =______ × w: = ______) - W: ______ × cos θ ______ = F_{r1} ______ Product Approval F′ ______

(P_2: ______ × L ______ =______ × w: = ______) - W: ______ × cos θ ______ = F_{r2} ______ Product Approval F′ ______

(P_3: ______ × L ______ =______ × w: = ______) - W: ______ × cos θ ______ = F_{r3} ______ Product Approval F′ ______

Where to Obtain Information		
Description	**Symbol**	**Where to find**
Design Pressure	P1 or P2 or P3	RAS 127 Table 1 or by an engineering analysis prepared by PE based on ASCE 7
Mean Roof Height	H	Job Site
Roof Slope	θ	Job Site
Aerodynamic Multiplier	λ	Product Approval
Restoring Moment due to Gravity	M_g	Product Approval
Attachment Resistance	M_f	Product Approval
Required Moment Resistance	M_g	Calculated
Minimum Attachment Resistance	F′	Product Approval
Required Uplift Resistance	Fr	Calculated
Average Tile Weight	W	Product Approval
Tile Dimensions	L = length W = width	Product Approval
All calculations must be submitted to the building official at the time of permit application.		

CHAPTER 16
STRUCTURAL DESIGN

SECTION 1601 GENERAL

1601.1 Scope. The provisions of this chapter shall govern the structural design of buildings, structures and portions thereof regulated by this code.

> **Exception:** Buildings and structures located within the high-velocity hurricane zone shall comply with the provisions of Sections 1612 through 1626.

SECTION 1602 DEFINITIONS AND NOTATIONS

1602.1 Definitions. The following words and terms shall, for the purposes of this chapter, have the meanings shown herein.

ALLOWABLE STRESS DESIGN. A method of proportioning structural members, such that elastically computed stresses produced in the members by nominal loads do not exceed specified allowable stresses (also called "working stress design").

BALCONY, EXTERIOR. An exterior floor projecting from and supported by a structure without additional independent supports.

BASE SHEAR. Total design lateral force or shear at the base.

DEAD LOADS. The weight of materials of construction incorporated into the building, including but not limited to walls, floors, roofs, ceilings, stairways, built-in partitions, finishes, cladding and other similarly incorporated architectural and structural items, and the weight of fixed service equipment, such as cranes, plumbing stacks and risers, electrical feeders, heating, ventilating and air-conditioning systems and fire sprinkler systems.

DECK. An exterior floor supported on at least two opposing sides by an adjacent structure, and/or posts, piers or other independent supports.

DESIGN STRENGTH. The product of the nominal strength and a resistance factor (or strength reduction factor).

DIAPHRAGM. A horizontal or sloped system acting to transmit lateral forces to the vertical-resisting elements. When the term "diaphragm" is used, it shall include horizontal bracing systems.

> **Diaphragm, blocked.** In light-frame construction, a diaphragm in which all sheathing edges not occurring on a framing member are supported on and fastened to blocking.
>
> **Diaphragm boundary.** In light-frame construction, a location where shear is transferred into or out of the diaphragm sheathing. Transfer is either to a boundary element or to another force-resisting element.
>
> **Diaphragm chord.** A diaphragm boundary element perpendicular to the applied load that is assumed to take axial stresses due to the diaphragm moment.
>
> **Diaphragm flexible.** A diaphragm is flexible for the purpose of distribution of story shear and torsional moment where so indicated in Section 12.3.1 of ASCE 7, as modified in Section 1613.6.1.
>
> **Diaphragm, rigid.** A diaphragm is rigid for the purpose of distribution of story shear and torsional moment when the lateral deformation of the diaphragm is less than or equal to two times the average story drift.

DURATION OF LOAD. The period of continuous application of a given load, or the aggregate of periods of intermittent applications of the same load.

ESSENTIAL FACILITIES. Buildings and other structures that are intended to remain operational in the event of extreme environmental loading from flood, wind, snow or earthquakes.

FABRIC PARTITION. A partition consisting of a finished surface made of fabric, without a continuous rigid backing, that is directly attached to a framing system in which the vertical framing members are spaced greater than 4 feet (1219 mm) on center.

FACTORED LOAD. The product of a nominal load and a load factor.

GUARD. See Section 1002.1.

IMPACT LOAD. The load resulting from moving machinery, elevators, craneways, vehicles and other similar forces and kinetic loads, pressure and possible surcharge from fixed or moving loads.

LIMIT STATE. A condition beyond which a structure or member becomes unfit for service and is judged to be no longer useful for its intended function (serviceability limit state) or to be unsafe (strength limit state).

LIVE LOADS. Those loads produced by the use and occupancy of the building or other structure and do not include construction or environmental loads such as wind load, snow load, rain load, earthquake load, flood load or dead load.

LIVE LOADS (ROOF). Those loads produced (1) during maintenance by workers, equipment and materials; and (2) during the life of the structure by movable objects such as planters and by people.

LOAD AND RESISTANCE FACTOR DESIGN (LRFD). A method of proportioning structural members and their connections using load and resistance factors such that no applicable limit state is reached when the structure is subjected to appropriate load combinations. The term "LRFD" is used in the design of steel and wood structures.

LOAD EFFECTS. Forces and deformations produced in structural members by the applied loads.

LOAD FACTOR. A factor that accounts for deviations of the actual load from the nominal load, for uncertainties in the analysis that transforms the load into a load effect, and for the probability that more than one extreme load will occur simultaneously.

LOADS. Forces or other actions that result from the weight of building materials, occupants and their possessions, environmental effects, differential movement and restrained dimensional changes. Permanent loads are those loads in which variations over time are rare or of small magnitude, such as dead loads. All other loads are variable loads (see also "Nominal loads").

NOMINAL LOADS. The magnitudes of the loads specified in this chapter (dead, live, soil, wind, snow, rain, flood and earthquake).

OCCUPANCY CATEGORY. A category used to determine structural requirements based on occupancy.

OTHER STRUCTURES. Structures, other than buildings, for which loads are specified in this chapter.

PANEL (PART OF A STRUCTURE). The section of a floor, wall or roof comprised between the supporting frame of two adjacent rows of columns and girders or column bands of floor or roof construction.

PRODUCTION GREENHOUSE. Greenhouses that are occupied for growing plants on a product or research basis without public access.

RESISTANCE FACTOR. A factor that accounts for deviations of the actual strength from the nominal strength and the manner and consequences of failure (also called "strength reduction factor").

STRENGTH, NOMINAL. The capacity of a structure or member to resist the effects of loads, as determined by computations using specified material strengths and dimensions and equations derived from accepted principles of structural mechanics or by field tests or laboratory tests of scaled models, allowing for modeling effects and differences between laboratory and field conditions.

STRENGTH, REQUIRED. Strength of a member, cross section or connection required to resist factored loads or related internal moments and forces in such combinations as stipulated by these provisions.

STRENGTH DESIGN. A method of proportioning structural members such that the computed forces produced in the members by factored loads do not exceed the member design strength [also called "load and resistance factor design" (LRFD)]. The term "strength design" is used in the design of concrete and masonry structural elements.

VEHICLE BARRIER SYSTEM. A system of building components near open sides of a garage floor or ramp or building walls that act as restraints for vehicles.

NOTATIONS.

D = Dead load.

F = Load due to fluids with well-defined pressures and maximum heights.

F_a = Flood load.

H = Load due to lateral earth pressures, ground water pressure or pressure of bulk materials.

L = Live load, except roof live load, including any permitted live load reduction.

L_r = Roof live load including any permitted live load reduction.

R = Rain load.

T = Self-straining force arising from contraction or expansion resulting from temperature change, shrinkage, moisture change, creep in component materials, movement due to differential settlement or combinations thereof.

W = Load due to wind pressure.

SECTION 1603
CONSTRUCTION DOCUMENTS

1603.1 General. Construction documents shall show the size, section and relative locations of structural members with floor levels, column centers and offsets fully dimensioned. The design loads and other information pertinent to the structural design required by Sections 1603.1.1 through 1603.1.8 shall be clearly indicated on the construction documents for parts of the building or structure.

Exception: Construction documents for buildings constructed in accordance with the conventional light-frame construction provisions of Section 2308 shall indicate the following structural design information:

1. Floor and roof live loads.
2. Basic wind speed (3-second gust), miles per hour (mph) (m/s) and wind exposure.

1603.1.1 Floor live load. The uniformly distributed, concentrated and impact floor live load used in the design shall be indicated for floor areas. Use of live load reduction in accordance with Section 1607.9 shall be indicated for each type of live load used in the design.

1603.1.2 Roof live load. The roof live load used in the design shall be indicated for roof areas (Section 1607.11).

1603.1.3 Roof snow load. Reserved.

1603.1.4 Wind design data. The following information related to wind loads shall be shown, regardless of whether wind loads govern the design of the lateral-force-resisting system of the building:

1. Basic wind speed (3-second gust), miles per hour (m/s).
2. Wind importance factor, I_W, and building classification from Table 1604.5 or Table 6-1, ASCE 7 and building classification in Table 1-1, ASCE 7.
3. Wind exposure. Where more than one wind exposure is utilized, the wind exposure and applicable wind direction shall be indicated.
4. The applicable enclosure classifications and, if designing with ASCE 7, internal pressure coefficient.
5. Components and cladding. The design wind pressures in terms of psf (kN/m^2) to be used for the selection of exterior components and cladding materials

not specifically designed by the registered design professional.

1603.1.5 Earthquake design data. Reserved.

1603.1.6 Flood design data. Reserved.

1603.1.7 Special loads. Special loads that are applicable to the design of the building, structure or portions thereof shall be indicated along with the specified section of this code that addresses the special loading condition.

1603.1.8 Systems and components requiring special inspections for seismic resistance. Reserved.

1603.2 Restrictions on loading. It shall be unlawful to place, or cause or permit to be placed, on any floor or roof of a building, structure or portion thereof, a load greater than is permitted by these requirements.

1603.3 Live loads posted. Where the live loads for which each floor or portion thereof of a commercial or industrial building is or has been designed to exceed 50 psf (2.40 kN/m^2), such design live loads shall be conspicuously posted by the owner in that part of each story in which they apply, using durable signs. It shall be unlawful to remove or deface such notices.

1603.4 Occupancy permits for changed loads. Occupancy permits for buildings hereafter erected shall not be issued until the floor load signs, required by Section 1603.3, have been installed.

SECTION 1604 GENERAL DESIGN REQUIREMENTS

1604.1 General. Building, structures and parts thereof shall be designed and constructed in accordance with strength design, load and resistance factor design, allowable stress design, empirical design or conventional construction methods, as permitted by the applicable material chapters.

1604.2 Strength. Buildings and other structures, and parts thereof, shall be designed and constructed to support safely the factored loads in load combinations defined in this code without exceeding the appropriate strength limit states for the materials of construction. Alternatively, buildings and other structures, and parts thereof, shall be designed and constructed to support safely the nominal loads in load combinations defined in this code without exceeding the appropriate specified allowable stresses for the materials of construction.

Loads and forces for occupancies or uses not covered in this chapter shall be subject to the approval of the building official.

1604.3 Serviceability. Structural systems and members thereof shall be designed to have adequate stiffness to limit deflections and lateral drift.

1604.3.1 Deflections. The deflections of structural members shall not exceed the more restrictive of the limitations of Sections 1604.3.2 through 1604.3.5 or that permitted by Table 1604.3.

1604.3.2 Reinforced concrete. The deflection of reinforced concrete structural members shall not exceed that permitted by ACI 318.

1604.3.3 Steel. The deflection of steel structural members shall not exceed that permitted by AISC 360, AISI-NAS, AISI-General, AISI-Truss, ASCE 3, ASCE 8, SJI JG-1.1, SJI K-1.1 or SJI LH/DLH-1.1, as applicable.

1604.3.4 Masonry. The deflection of masonry structural members shall not exceed that permitted by ACI 530/ASCE 5/TMS 402.

1604.3.5 Aluminum. The deflection of aluminum structural members shall not exceed that permitted by AA ADM1.

1604.3.6 Limits. Deflection of structural members over span, l, shall not exceed that permitted by Table 1604.3.

TABLE 1604.3 DEFLECTION LIMITS[a, b, c, h, i, j]

CONSTRUCTION	L	S or W[f]	$D + L$[d,g]
Roof members:[e]			
Supporting plaster ceiling	$l/360$	$l/360$	$l/240$
Supporting nonplaster ceiling	$l/240$	$l/240$	$l/180$
Not supporting ceiling	$l/180$	$l/180$	$l/120$
Members supporting screen surface	----	-----	$l/60$
Floor members	$l/360$	—	$l/240$
Exterior walls and interior partitions:			
With brittle finishes	—	$l/240$	—
With flexible finishes	—	$l/120$	—
Farm buildings	—	—	$l/180$
Greenhouses	—	—	$l/120$

For SI: 1 foot = 304.8 mm.

a. For structural roofing and siding made of formed metal sheets, the total load deflection shall not exceed $l/60$. For secondary roof structural members supporting formed metal roofing, the live load deflection shall not exceed $l/150$. For secondary wall members supporting formed metal siding, the design wind load deflection shall not exceed $l/90$. For roofs, this exception only applies when the metal sheets have no roof covering.

b. Interior partitions not exceeding 6 feet in height and flexible, folding and portable partitions are not governed by the provisions of this section. The deflection criterion for interior partitions is based on the horizontal load defined in Section 1607.13.

c. See Section 2403 for glass supports.

d. For wood structural members having a moisture content of less than 16 percent at time of installation and used under dry conditions, the deflection resulting from $L + 0.5D$ is permitted to be substituted for the deflection resulting from $L + D$.

e. The above deflections do not ensure against ponding. Roofs that do not have sufficient slope or camber to assure adequate drainage shall be investigated for ponding. See Section 1611 for rain and ponding requirements and Section 1503.4 for roof drainage requirements.

f. The wind load is permitted to be taken as 0.7 times the "component and cladding" loads for the purpose of determining deflection limits herein.

g. For steel structural members, the dead load shall be taken as zero.

h. For aluminum structural members or aluminum panels used in skylights and sloped glazing framing, roofs or walls of sunroom additions or patio covers, not supporting edge of glass or aluminum sandwich panels, the total load deflection shall not exceed l/60. For aluminum sandwich panels used in roofs or walls of sunroom additions or patio covers, the total load deflection shall not exceed l/120.

i. For cantilever members, l shall be taken as twice the length of the cantilever.

j. Screen surfaces shall be permitted to include a maximum of 25% solid flexible finishes.

1604.4 Analysis. Load effects on structural members and their connections shall be determined by methods of structural analysis that take into account equilibrium, general stability, geometric compatibility and both short- and long-term material properties.

Members that tend to accumulate residual deformations under repeated service loads shall have included in their analysis the added eccentricities expected to occur during their service life.

Any system or method of construction to be used shall be based on a rational analysis in accordance with well-established principles of mechanics. Such analysis shall result in a system that provides a complete load path capable of transferring loads from their point of origin to the load-resisting elements.

The total lateral force shall be distributed to the various vertical elements of the lateral-force-resisting system in proportion to their rigidities, considering the rigidity of the horizontal bracing system or diaphragm. Rigid elements assumed not to be a part of the lateral-force-resisting system are permitted to be incorporated into buildings provided their effect on the action of the system is considered and provided for in the design. Except where diaphragms are flexible, or are permitted to be analyzed as flexible, provisions shall be made for the increased forces induced on resisting elements of the structural system resulting from torsion due to eccentricity between the center of application of the lateral forces and the center of rigidity of the lateral-force-resisting system.

Every structure shall be designed to resist the overturning effects caused by the lateral forces specified in this chapter. See Section 1609 for wind loads, and Section 1610 for lateral soil loads.

1604.5 Occupancy category. Buildings shall be assigned an occupancy category in accordance with Table 1604.5.

1604.5.1 Multiple occupancies. Where a structure is occupied by two or more occupancies not included in the same occupancy category, the structure shall be assigned the classification of the highest occupancy category corresponding to the various occupancies. Where structures have two or more portions that are structurally separated, each portion shall be separately classified. Where a separated portion of a structure provides required access to, required egress from or shares life safety components with another portion having a higher occupancy category, both portions shall be assigned to the higher occupancy category.

1604.6 In-situ load tests. The building official is authorized to require an engineering analysis or a load test, or both, of any construction whenever there is reason to question the safety of the construction for the intended occupancy. Engineering analysis and load tests shall be conducted in accordance with Section 1713.

1604.7 Preconstruction load tests. Materials and methods of construction that are not capable of being designed by approved engineering analysis or that do not comply with the applicable material design standards listed in Chapter 35, or alternative test procedures in accordance with Section 1711, shall be load tested in accordance with Section 1714.

1604.8 Anchorage.

1604.8.1 General. Anchorage of the roof to walls and columns, and of walls and columns to foundations, shall be provided to resist the uplift and sliding forces that result from the application of the prescribed loads.

1604.8.2 Concrete and masonry walls. Concrete and masonry walls shall be anchored to floors, roofs and other structural elements that provide lateral support for the wall. Such anchorage shall provide a positive direct connection capable of resisting the horizontal forces specified in this chapter but not less than a minimum strength design horizontal force of 280 plf (4.10 kN/m) of wall, unless the lateral force has otherwise been calculated by the Engineer of Record. Walls shall be designed to resist bending between anchors where the anchor spacing exceeds 4 feet (1219 mm). Required anchors in masonry walls of hollow units or cavity walls shall be embedded in a reinforced grouted structural element of the wall. See Sections 1609 for wind design requirements.

1604.8.3 Decks. Where supported by attachment to an exterior wall, decks shall be positively anchored to the primary structure and designed for both vertical and lateral loads as applicable. Such attachment shall not be accomplished by the use of toenails or nails subject to withdrawal. Where positive connection to the primary building structure cannot be verified during inspection, decks shall be self-supporting. For decks with cantilevered framing members, connections to exterior walls or other framing members shall be designed and constructed to resist uplift resulting from the full live load specified in Table 1607.1 acting on the cantilevered portion of the deck.

1604.9 Counteracting structural actions. Structural members, systems, components and cladding shall be designed to resist forces due to wind, with consideration of overturning, sliding, and uplift. Continuous load paths shall be provided for transmitting these forces to the foundation. Where sliding is used to isolate the elements, the effects of friction between sliding elements shall be included as a force.

1604.10 Wind and seismic detailing. Reserved.

SECTION 1605
LOAD COMBINATIONS

1605.1 General. Buildings and other structures and portions thereof shall be designed to resist the load combinations specified in Section 1605.2 or 1605.3 and Chapters 18 through 23. Applicable loads shall be considered, including wind, in accordance with the specified load combinations. Each load combination shall also be investigated with one or more of the variable loads set to zero.

1605.2 Load combinations using strength design or load and resistance factor design.

1605.2.1 Basic load combinations. Where strength design or load and resistance factor design is used, structures and portions thereof shall resist the most critical effects from the following combinations of factored loads:

$1.4\,(D+F)$ **(Equation 16-1)**

$1.2(D + F + T) + 1.6(L + H) +$
$0.5\,(L_r \text{ or } R)$ **(Equation 16-2)**

TABLE 1604.5
OCCUPANCY CATEGORY OF BUILDINGS AND OTHER STRUCTURES

OCCUPANCY CATEGORY	NATURE OF OCCUPANCY
I	Buildings and other structures that represent a low hazard to human life in the event of failure, including but not limited to: • Agricultural facilities. • Certain temporary facilities. • Minor storage facilities. • Screen enclosures
II	Buildings and other structures except those listed in Occupancy Categories I, III and IV
III	Buildings and other structures that represent a substantial hazard to human life in the event of failure, including but not limited to: • Covered structures whose primary occupancy is public assembly with an occupant load greater than 300. • Buildings and other structures with elementary school, secondary school or day care facilities with an occupant load greater than 250. • Buildings and other structures with an occupant load greater than 500 for colleges or adult education facilities. • Health care facilities with an occupant load of 50 or more resident patients, but not having surgery or emergency treatment facilities. • Jails and detention facilities. • Any other occupancy with an occupant load greater than 5,000. • Power-generating stations, water treatment for potable water, waste water treatment facilities and other public utility facilities not included in Occupancy Category IV. • Buildings and other structures not included in Occupancy Category IV containing sufficient quantities of toxic or explosive substances to be dangerous to the public if released.
IV	Buildings and other structures designated as essential facilities, including but not limited to: • Hospitals and other health care facilities having surgery or emergency treatment facilities. • Fire, rescue and police stations and emergency vehicle garages. • Designated hurricane or other emergency shelters. • Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response. • Power-generating stations and other public utility facilities required as emergency backup facilities for Occupancy Category IV structures. • Structures containing highly toxic materials as defined by Section 307 where the quantity of the material exceeds the maximum allowable quantities of Table 307.1.(2). • Aviation control towers, air traffic control centers and emergency aircraft hangars. • Buildings and other structures having critical national defense functions. • Water treatment facilities required to maintain water pressure for fire suppression.

$1.2D + 1.6(L_r \text{ or } R) + (f_1L \text{ or } 0.8W)$ **(Equation 16-3)**

$1.2D + 1.6W + f_1L + 0.5(L_r \text{ or } R)$ **(Equation 16-4)**

$1.2D + f_1L$ **(Equation 16-5)**

$0.9D + 1.6W + 1.6H$ **(Equation 16-6)**

$0.9D + 1.6H$ **(Equation 16-7)**

f_1 = 1 for floors in places of public assembly, for live loads in excess of 100 pounds per square foot (4.79 kN/m^2), and for parking garage live load, and

= 0.5 for other live loads

Exception: Where other factored load combinations are specifically required by the provisions of this code, such combinations shall take precedence.

1605.2.2 Other loads. Where F_a is to be considered in the design, the load combinations of Section 2.3.3 of ASCE 7 shall be used.

1605.3 Load combinations using allowable stress design.

1605.3.1 Basic load combinations. Where allowable stress design (working stress design), as permitted by this code, is used, structures and portions thereof shall resist the most critical effects resulting from the following combinations of loads:

$D + F$ **(Equation 16-8)**

$D + H + F + L + T$ **(Equation 16-9)**

$D + H + F + (L_r \text{ or } R)$ **(Equation 16-10)**

$D + H + F + 0.75(L + T) + 0.75\ (L_r \text{ or } R)$ **(Equation 16-11)**

$D + H + F + (W)$ **(Equation 16-12)**

$D + H + F + 0.75(W) + 0.75L + 0.75\ (L_r \text{ or } R)$ **(Equation 16-13)**

$0.6D + W + H$ **(Equation 16-14)**

$0.6D + H$ **(Equation 16-15)**

Exception: Crane hook loads need not be combined with roof live load or with more than three-fourths of the snow load or one-half of the wind load.

1605.3.1.1 Load reduction.

1. It is permitted to multiply the combined effect of two or more variable loads by 0.75 and add the effect of dead load. The combined load used in design shall not be less than the sum of the effect of dead load and any of the variable loads.

2. Increases in allowable stress specified in the materials sections of this code or a referenced standard shall not be permitted to be used with load combinations of Sections 1605.3.1. Duration of load increase shall be permitted in accordance with Chapter 23.

   Exception: Increases in allowable stress shall be permitted in accordance with ACI 530/ASCE 5/TMS 402 provided the load reduction of Section 1605.3.1.1 Item 1 shall not be applied.

3. Simultaneous use of both one-third increase in allowable stress and the 25 percent reduction in combined loads shall not be permitted.

1605.3.1.2 Other loads. Where F_a is to be considered in design, the load combinations of Section 2.4.2 of ASCE 7 shall be used.

1605.3.2 Alternative basic load combinations. In lieu of the basic load combinations specified in Section 1605.3.1, structures and portions thereof shall be permitted to be designed for the most critical effects resulting from the following combinations. When using these alternative basic load combinations that include wind loads, allowable stresses are permitted to be increased or load combinations reduced where permitted by the material chapter of this code or the referenced standards. For load combinations that include the counteracting effects of dead and wind loads, only two-thirds of the minimum dead load likely to be in place during a design wind event shall be used. Where wind loads are calculated in accordance with Chapter 6 of ASCE 7, the coefficient ω in the following equations shall be taken as 1.3. For other wind loads, ω shall be taken as 1. When using these alternative load combinations to evaluate sliding, overturning and soil bearing at the soil-structure interface, the reduction of foundation overturning from Section 12.13.4 in ASCE 7 shall not be used.

$D + L + (L_r \text{ or } R)$ **(Equation 16-16)**

$D + L + (\omega W)$ **(Equation 16-17)**

Equation 16-18. Reserved.

$D + L + \omega W/2$ **(Equation 16-19)**

$D + L$ **(Equation 16-20)**

$0.9D$ **(Equation 16-21)**

Exception: Crane hook loads need not be combined with roof live load or with more than three-fourths of the snow load or one-half of the wind load.

1605.3.2.1 Other loads. Where F, H or T are to be considered in the design, each applicable load shall be added to the combinations specified in Section 1605.3.2.

1605.4 Special seismic load combinations. Reserved.

1605.5 Heliports and helistops. Heliport and helistop landing areas shall be designed for the following loads, combined in accordance with Section 1605:

1. Dead load, D, plus the gross weight of the helicopter, Dh, plus snow load, S.

2. Dead load, D, plus two single concentrated impact loads, L, approximately 8 feet (2438 mm) apart applied anywhere on the landing area (representing the helicopter's two main landing gear, whether skid type or wheeled type), having a magnitude of 0.75 times the gross weight of the helicopter. Both loads acting together total one-and one half times the gross weight of the helicopter.

3. Dead load, D, plus a uniform live load, L, of 100 psf (4.79 kN/m^2).

   Exception: Landing areas designed for helicopters with gross weights not exceeding 3,000 pounds (13.34 kN) in accordance with Items 1 and 2 shall be permitted to be designed using a 40 psf (1.92 kN/m^2) uniform live load in Item 3, provided the landing area is identified with a 3,000 pound (13.34 kN) weight limitation. This 40 psf (1.92 kN/m^2) uniform live load shall not be reduced. The landing area weight limitation shall be indicated by the numeral "3" (kips) located in the bottom right corner of the landing area as viewed from the primary approach path. The landing area weight limitation shall be a minimum of 5 feet (1524 mm) in height.

SECTION 1606 DEAD LOADS

1606.1 General. Dead loads are those loads defined in Section 1602.1. Dead loads shall be considered permanent loads.

1606.2 Design dead load. For purposes of design, the actual weights of materials of construction and fixed service equipment shall be used. In the absence of definite information, values used shall be subject to the approval of the building official.

SECTION 1607 LIVE LOADS

1607.1 General. Live loads are those loads defined in Section 1602.1.

1607.2 Loads not specified. For occupancies or uses not designated in Table 1607.1, the live load shall be determined in accordance with a method approved by the building official.

1607.3 Uniform live loads. The live loads used in the design of buildings and other structures shall be the maximum loads expected by the intended use or occupancy but shall in no case be less than the minimum uniformly distributed unit loads required by Table 1607.1.

1607.4 Concentrated loads. Floors and other similar surfaces shall be designed to support the uniformly distributed live loads prescribed in Section 1607.3 or the concentrated load, in pounds (kilonewtons), given in Table 1607.1, whichever produces the greater load effects. Unless otherwise specified, the indicated concentration shall be assumed to be uniformly distributed over an area 2.5 feet by 2.5 feet [6.25 square feet (0.58 m^2)] and shall be located so as to produce the maximum load effects in the structural members.

1607.5 Partition loads. In office buildings and in other buildings where partition locations are subject to change, provisions for partition weight shall be made, whether or not partitions are shown on the construction documents, unless the specified live load exceeds 80 psf (3.83 kN/m^2). The partition load shall not be less than a uniformly distributed live load of 15 psf (0.74 kN/m^2).

1607.6 Truck and bus garages. Minimum live loads for garages having trucks or buses shall be as specified in Table 1607.6, but shall not be less than 50 psf (2.40 kN/m^2), unless other loads are specifically justified and approved by the building official. Actual loads shall be used where they are greater than the loads specified in the table.

TABLE 1607.6
UNIFORM AND CONCENTRATED LOADS

LOADING CLASS[a]	UNIFORM LOAD (pounds/linear foot of lane)	CONCENTRATED LOAD (pounds)[b]	
		For moment design	For shear design
H20-44 and HS20-44	640	18,000	26,000
H15-44 and HS15-44	480	13,500	19,500

For SI: 1 pound per linear foot = 0.01459 kN/m, 1 pound = 0.004448 kN, 1 ton = 8.90 kN.

a. An H loading class designates a two-axle truck with a semitrailer. An HS loading class designates a tractor truck with a semitrailer. The numbers following the letter classification indicate the gross weight in tons of the standard truck and the year the loadings were instituted.

b. See Section 1607.6.1 for the loading of multiple spans.

1607.6.1 Truck and bus garage live load application. The concentrated load and uniform load shall be uniformly distributed over a 10-foot (3048 mm) width on a line normal to the centerline of the lane placed within a 12-foot-wide (3658 mm) lane. The loads shall be placed within their individual lanes so as to produce the maximum stress in each structural member. Single spans shall be designed for the uniform load in Table 1607.6 and one simultaneous concentrated load positioned to produce the maximum effect. Multiple spans shall be designed for the uniform load in Table 1607.6 on the spans and two simultaneous concentrated loads in two spans positioned to produce the maximum negative moment effect. Multiple span design loads, for other effects, shall be the same as for single spans.

1607.7 Loads on handrails, guards, grab bars and vehicle barriers. Handrails, guards, grab bars as designed in Chapter 11 and vehicle barriers shall be designed and constructed to the structural loading conditions set forth in this section.

1607.7.1 Handrails and guards. Handrail assemblies and guards shall be designed to resist a load of 50 plf (0.73 kN/m) applied in any direction at the top and to transfer this load through the supports to the structure. Glass handrail assemblies and guards shall also comply with Section 2407.

Exceptions:

1. For one- and two-family dwellings, only the single concentrated load required by Section 1607.7.1.1 shall be applied.
2. In Group I-3, F, H and S occupancies, for areas that are not accessible to the general public and that have an occupant load less than 50, the minimum load shall be 20 pounds per foot (0.29 kN/m).

1607.7.1.1 Concentrated load. Handrail assemblies and guards shall be able to resist a single concentrated load of 200 pounds (0.89 kN), applied in any direction at any point along the top, and have attachment devices and supporting structure to transfer this loading to appropri-

TABLE 1607.1
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS AND MINIMUM CONCENTRATED LIVE LOADS[g]

OCCUPANCY OR USE	UNIFORM (psf)	CONCENTRATED (lbs.)
1. Apartments (see residential)	—	—
2. Access floor systems Office use Computer use	 50 100	 2,000 2,000
3. Armories and drill rooms	150	—
4. Assembly areas and theaters Fixed seats (fastened to floor) Follow spot, projections and control rooms Lobbies Movable seats Stages and platforms	 60 50 100 100 125	—
5. Balconies On one- and two-family residences only, and not exceeding 100 sq ft	100 60	—
6. Bowling alleys	75	—
7. Catwalks	40	300
8. Dance halls and ballrooms	100	—
9. Decks	Same as occupancy served[h]	—
10. Dining rooms and restaurants	100	—
11. Dwellings (see residential)	—	—
12. Cornices	60	—
13. Corridors, except as otherwise indicated	100	—
14. Elevator machine room grating (on area of 4 in^2)	—	300
15. Finish light floor plate construction (on area of 1 in^2)	— —	200
16. Fire escapes On single-family dwellings only	100 40	—
17. Garages (passenger vehicles only) Trucks and buses	40 See Section 1607.6	Note a
18. Grandstands (see stadium and arena bleachers)	—	—
19. Gymnasiums, main floors and balconies	100	—
20. Handrails, guards and grab bars	See Section 1607.7	
21. Hospitals Corridors above first floor Operating rooms, laboratories Patient rooms	 80 60 40	 1,000 1,000 1,000
22. Hotels (see residential)	—	—
23. Libraries Corridors above first floor Reading rooms Stack rooms	 80 60 150[b]	 1,000 1,000 1,000
24. Manufacturing Heavy Light	 250 125	 3,000 2,000
25. Marquees	75	—
26. Office buildings Corridors above first floor File and computer rooms shall be designed for heavier loads based on anticipated occupancy Lobbies and first-floor corridors Offices	 80 — 100 50	 2,000 — 2,000 2,000
27. Penal institutions Cell blocks Corridors	 40 100	—
28. Residential One- and two-family dwellings Uninhabitable attics without storagei Uninhabitable attics with limited storage[i, j, k] Habitable attics and sleeping areas All other areas except balconies and decks Hotels and multiple-family dwellings Private rooms and corridors serving them Public rooms and corridors serving them	 10 20 30 40 40 100	—
29. Reviewing stands, grandstands and bleachers	Note c	
30. Roofs All roof surfaces subject to maintenance workers Awnings and canopies Fabric construction supported by a lightweight rigid skeleton structure All other construction Ordinary flat, pitched, and curved roofs Primary roof members, exposed to a work floor Single panel point of lower chord of roof trusses or any point along primary structural members supporting roofs: Over manufacturing, storage warehouses, and repair garages All other occupancies Roofs used for other special purposes Roofs used for promenade purposes Roofs used for roof gardens or assembly purposes	 5 nonreduceable 20 20 Note 1 60 100	 300 2,000 300 Note 1

(continued)

TABLE 1607.1—continued
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS AND MINIMUM CONCENTRATED LIVE LOADS[g]

OCCUPANCY OR USE	UNIFORM (psf)	CONCENTRATED (lbs.)
31. Schools Classrooms Corridors above first floor First-floor corridors	 40 80 100	 1,000 1,000 1,000
32. Scuttles, skylight ribs and accessible ceilings	—	200
33. Sidewalks, vehicular driveways and yards, subject to trucking	250d	8,000e
34. Skating rinks	100	—
35. Stadiums and arenas Bleachers Fixed seats (fastened to floor)	 100c 60c	—
36. Stairs and exits One- and two-family dwellings All other	 40 100	Note f
37. Storage warehouses (shall be designed for heavier loads if required for anticipated storage) Heavy Light	 250 125	
38. Stores Retail First floor Upper floors Wholesale, all floors	 100 75 125	 1,000 1,000 1,000
39. Vehicle barriers	See Section 1607.7.3	
40. Walkways and elevated platforms (other than exitways)	60	—
41. Yards and terraces, pedestrians	100	—

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm^2,
1 square foot = 0.0929 m^2,
1 pound per square foot = 0.0479 kN/m^2, 1 pound = 0.004448 kN,
1 pound per cubic foot = 16 kg/m^3

a. Floors in garages or portions of buildings used for the storage of motor vehicles shall be designed for the uniformly distributed live loads of Table 1607.1 or the following concentrated loads: (1) for garages restricted to vehicles accommodating not more than nine passengers, 3,000 pounds acting on an area of 4.5 inches by 4.5 inches; (2) for mechanical parking structures without slab or deck which are used for storing passenger vehicles only, 2,250 pounds per wheel.

b. The loading applies to stack room floors that support nonmobile, double-faced library bookstacks, subject to the following limitations:
   1. The nominal bookstack unit height shall not exceed 90 inches;
   2. The nominal shelf depth shall not exceed 12 inches for each face; and
   3. Parallel rows of double-faced bookstacks shall be separated by aisles not less than 36 inches wide.

c. Design in accordance with the ICC Standard on Bleachers, Folding and Telescopic Seating and Grandstands.

d. Other uniform loads in accordance with an approved method which contains provisions for truck loadings shall also be considered where appropriate.

e. The concentrated wheel load shall be applied on an area of 20 square inches.

f. Minimum concentrated load on stair treads (on area of 4 square inches) is 300 pounds.

g. Reserved.

h. See Section 1604.8.3 for decks attached to exterior walls.

i. Attics without storage are those where the maximum clear height between the joist and rafter is less than 42 inches, or where there are not two or more adjacent trusses with the same web configuration capable of containing a rectangle 42 inches high by 2 feet wide, or greater, located within the plane of the truss. For attics without storage, this live load need not be assumed to act concurrently with any other live load requirements.

j. For attics with limited storage and constructed with trusses, this live load need be applied only to those portions of the bottom chord where there are two or more adjacent trusses with the same web configuration capable of containing a rectangle 42 inches high by 2 feet wide or greater, located within the plane of the truss. The rectangle shall fit between the top of the bottom chord and the bottom of any other truss member, provided that each of the following criteria is met:
   i. The attic area is accessible by a pull-down stairway or framed opening in accordance with Section 1209.2, and
   ii. The truss shall have a bottom chord pitch less than 2:12.
   iii. Bottom chords of trusses shall be designed for the greater of actual imposed dead load or 10 psf, uniformly distributed over the entire span.

k. Attic spaces served by a fixed stair shall be designed to support the minimum live load specified for habitable attics and sleeping rooms.

l. Roofs used for other special purposes shall be designed for appropriate loads as approved by the building official.

ate structural elements of the building. This load need not be assumed to act concurrently with the loads specified in the preceding paragraph.

1607.7.1.2 Components. Intermediate rails (all those except the handrail), balusters and panel fillers shall be designed to withstand a horizontally applied normal load of 50 pounds (0.22 kN) on an area equal to 1 square foot (0.093 m^2), including openings and space between rails. Reactions due to this loading are not required to be superimposed with those of Section 1607.7.1 or 1607.7.1.1.

1607.7.1.3 Stress increase. Where handrails and guards are designed in accordance with the provisions for allowable stress design (working stress design) exclusively for the loads specified in Section 1607.7.1, the allowable stress for the members and their attachments is permitted to be increased by one-third.

1607.7.2 Grab bars, shower seats and dressing room bench seats. Grab bars, shower seats and dressing room bench seat systems shall be designed to resist a single concentrated load of 250 pounds (1.11 kN) applied in any direction at any point.

1607.7.3 Vehicle barriers. Vehicle barrier systems for passenger cars shall be designed to resist a single load of 6,000 pounds (26.70 kN) applied horizontally in any direction to the barrier system and shall have anchorage or attachment capable of transmitting this load to the structure. For design of the system, the load shall be assumed to act at a minimum height of 1 foot, 6 inches (457 mm) above the floor or ramp surface on an area not to exceed 1 square foot (305 mm^2), and is not required to be assumed to act concurrently with any handrail or guard loadings specified in the preceding paragraphs of Section 1607.7.1. Garages accommodating trucks and buses shall be designed in accordance with an approved method that contains provision for traffic railings.

1607.8 Impact loads. The live loads specified in Section 1607.3 include allowance for impact conditions. Provisions shall be made in the structural design for uses and loads that involve unusual vibration and impact forces.

1607.8.1 Elevators. Elevator loads shall be increased by 100 percent for impact and the structural supports shall be designed within the limits of deflection prescribed by ASME A17.1.

1607.8.2 Machinery. For the purpose of design, the weight of machinery and moving loads shall be increased as follows to allow for impact: (1) elevator machinery, 100 percent; (2) light machinery, shaft- or motor-driven, 20 percent; (3) reciprocating machinery or power-driven units, 50 percent; (4) hangers for floors or balconies, 33 percent. Percentages shall be increased where specified by the manufacturer.

1607.9 Reduction in live loads. Except for roof uniform live loads, all other minimum uniformly distributed live loads, L_o, in Table 1607.1 are permitted to be reduced in accordance with Section 1607.9.1 or 1607.9.2.

1607.9.1 General. Subject to the limitations of Sections 1607.9.1.1 through 1607.9.1.4, members for which a value of $K_{LL}A_T$ is 400 square feet (37.16 m^2) or more are permitted to be designed for a reduced live load in accordance with the following equation:

$$L = L_o\left(0.25 + \frac{15}{\sqrt{K_{LL}A_T}}\right) \qquad \textbf{(Equation 16-24)}$$

For SI: $L = L_o\left(0.25 + \frac{4.57}{\sqrt{K_{LL}A_T}}\right)$

where:

L = Reduced design live load per square foot (meter) of area supported by the member.

L_o = Unreduced design live load per square foot (meter) of area supported by the member (see Table 1607.1).

K_{LL}= Live load element factor (see Table 1607.9.1).

A_T = Tributary area, in square feet (square meters).

L shall not be less than $0.50L_o$ for members supporting one floor and L shall not be less than $0.40L_o$ for members supporting two or more floors.

1607.9.1.1 Heavy live loads. Live loads that exceed 100 psf (4.79 kN/m^2) shall not be reduced.

Exceptions:

1. The live loads for members supporting two or more floors are permitted to be reduced by a maximum of 20 percent, but the live load shall not be less than L as calculated in Section 1607.9.1.
2. For uses other than storage, where approved, additional live load reductions shall be permitted where shown by the registered design professional that a rational approach has been used and that such reductions are warranted.

TABLE 1607.9.1
LIVE LOAD ELEMENT FACTOR, K_{LL}

ELEMENT	K_{LL}
Interior columns Exterior columns without cantilever slabs	4 4
Edge columns with cantilever slabs	3
Corner columns with cantilever slabs Edge beams without cantilever slabs Interior beams	2 2 2
All other members not identified above including: Edge beams with cantilever slabs Cantilever beams Two-way slabs Members without provisions for continuous shear transfer normal to their span	1

1607.9.1.2 Passenger vehicle garages. The live loads shall not be reduced in passenger vehicle garages except the live loads for members supporting two or more floors are permitted to be reduced by a maximum of 20 percent, but the live load shall not be less than L as calculated in Section 1607.9.1.

1607.9.1.3 Special occupancies. Live loads of 100 psf (4.79 kN/m^2) or less shall not be reduced in public assembly occupancies.

1607.9.1.4 Special structural elements. Live loads shall not be reduced for one-way slabs except as permitted in Section 1607.9.1.1. Live loads of 100 psf (4.79 kN/m^2) or less shall not be reduced for roof members except as specified in Section 1607.11.2.

1607.9.2 Alternate floor live load reduction. As an alternative to Section 1607.9.1, floor live loads are permitted to be reduced in accordance with the following provisions. Such reductions shall apply to slab systems, beams, girders, columns, piers, walls and foundations.

1. A reduction shall not be permitted in Group A occupancies.
2. A reduction shall not be permitted where the live load exceeds 100 psf (4.79 kN/m^2) except that the design live load for members supporting two or more floors is permitted to be reduced by 20 percent.
3. A reduction shall not be permitted in passenger vehicle parking garages except that the live loads for members supporting two or more floors are permitted to be reduced by a maximum of 20 percent.
4. For live loads not exceeding 100 psf (4.79 kN/m^2), the design live load for any structural member supporting 150 square feet (13.94 m^2) or more is permitted to be reduced in accordance with the following equation:

$$R = 0.08\,(A - 150) \qquad \textbf{(Equation 16-25)}$$

For SI: $R = 0.861\,(A - 13.94)$

Such reduction shall not exceed the smallest of:

1. 40 percent for horizontal members;

2. 60 percent for vertical members; or
3. R as determined by the following equation.

$R = 23.1\,(1 + D/L_o)$ **(Equation 16-26)**

where:

A = Area of floor supported by the member, square feet (m^2).

D = Dead load per square foot (m^2) of area supported.

L_o = Unreduced live load per square foot (m^2) of area supported.

R = Reduction in percent.

1607.10 Distribution of floor loads. Where uniform floor live loads are involved in the design of structural members arranged so as to create continuity, the minimum applied loads shall be the full dead loads on all spans in combination with the floor live loads on spans selected to produce the greatest effect at each location under consideration. It shall be permitted to reduce floor live loads in accordance with Section 1607.9.

1607.11 Roof loads. The structural supports of roofs and marquees shall be designed to resist wind loads, in addition to the dead load of construction and the appropriate live loads as prescribed in this section, or as set forth in Table 1607.1. The live loads acting on a sloping surface shall be assumed to act vertically on the horizontal projection of that surface.

1607.11.1 Distribution of roof loads. Where uniform roof live loads are reduced to less than 20 psf (0.96 kN/m^2) in accordance with Section 1607.11.2.1 and are involved in the design of structural members arranged so as to create continuity, the minimum applied loads shall be the full dead loads on all spans in combination with the roof live loads on adjacent spans or on alternate spans, whichever produces the greatest effect. See Section 1607.11.2 for minimum roof live loads.

1607.11.2 Reduction in roof live loads. The minimum uniformly distributed roof live loads, L_o, in Table 1607.1 are permitted to be reduced according to the following provisions.

1607.11.2.1 Flat, pitched and curved roofs. Ordinary flat, pitched and curved roofs are permitted to be designed for a reduced roof live load as specified in the following equation or other controlling combinations of loads in Section 1605, whichever produces the greater load. In structures where special scaffolding is used as a work surface for workers and materials during maintenance and repair operations, a lower roof load than specified in the following equation shall not be used unless approved by the building official. Greenhouses shall be designed for a minimum roof live load of 12 psf (0.58 kN/m^2).

$L_r = L_o R_1 R_2$ **(Equation 16-27)**

where: $12 \leq L_r \leq 20$

For SI: $L_r = L_o R_1 R_2$

where: $0.58 \leq L_r \leq 0.96$

L_r = Reduced live load per square foot (m^2) of horizontal projection in pounds per square foot (kN/m^2).

The reduction factors R_1 and R_2 shall be determined as follows:

$R_1 = 1$ for $A_t \leq 200$ square feet (18.58 m^2) **(Equation 16-28)**

$R_1 = 1.2 - 0.001A_t$ for 200 square feet $< A_t <$ 600 square feet **(Equation 16-29)**

For SI: $1.2 - 0.011A_t$ for 18.58 square meters $< A_t <$ 55.74 square meters

$R_1 = 0.6$ for $A_t > 600$ square feet (55.74 m^2) **(Equation 16-30)**

where:

A_t = Tributary area (span length multiplied by effective width) in square feet (m^2) supported by any structural member, and

$R_2 = 1$ for $F \leq 4$ **(Equation 16-31)**

$R_2 = 1.2 - 0.05\,F$ for $4 < F < 12$ **(Equation 16-32)**

$R_2 = 0.6$ for $F \geq 12$ **(Equation 16-33)**

where:

F = For a sloped roof, the number of inches of rise per foot (for SI: $F = 0.12 \times$ slope, with slope expressed as a percentage), or for an arch or dome, the rise-to-span ratio multiplied by 32.

1607.11.2.2 Special-purpose roofs. Roofs used for promenade purposes, roof gardens, assembly purposes or other special purposes shall be designed for a minimum live load as required in Table 1607.1. Such roof live loads are permitted to be reduced in accordance with 1607.9.

1607.11.2.3 Landscaped roofs. Where roofs are to be landscaped, the uniform design live load in the landscaped area shall be 20 psf (0.958 kN/m^2). The weight of the landscaping materials shall be considered as dead load and shall be computed on the basis of saturation of the soil.

1607.11.2.4 Awnings and canopies. Awnings and canopies shall be designed for uniform live loads as required in Table 1607.1 as well as for wind loads as specified in Section 1609.

1607.12 Crane loads. The crane live load shall be the rated capacity of the crane. Design loads for the runway beams, including connections and support brackets, of moving bridge cranes and monorail cranes shall include the maximum wheel loads of the crane and the vertical impact, lateral and longitudinal forces induced by the moving crane.

1607.12.1 Maximum wheel load. The maximum wheel loads shall be the wheel loads produced by the weight of the bridge, as applicable, plus the sum of the rated capacity and the weight of the trolley with the trolley positioned on its runway at the location where the resulting load effect is maximum.

1607.12.2 Vertical impact force. The maximum wheel loads of the crane shall be increased by the percentages shown below to determine the induced vertical impact or vibration force:

Monorail cranes (powered) · · · · · · · · · · 25 percent

Cab-operated or remotely operated bridge cranes (powered) · · · · · · · · · · · · 25 percent

Pendant-operated bridge cranes (powered) · 10 percent

Bridge cranes or monorail cranes with hand-geared bridge, trolley and hoist · · · · · 0 percent

1607.12.3 Lateral force. The lateral force on crane runway beams with electrically powered trolleys shall be calculated as 20 percent of the sum of the rated capacity of the crane and the weight of the hoist and trolley. The lateral force shall be assumed to act horizontally at the traction surface of a runway beam, in either direction perpendicular to the beam, and shall be distributed according to the lateral stiffness of the runway beam and supporting structure.

1607.12.4 Longitudinal force. The longitudinal force on crane runway beams, except for bridge cranes with hand-geared bridges, shall be calculated as 10 percent of the maximum wheel loads of the crane. The longitudinal force shall be assumed to act horizontally at the traction surface of a runway beam, in either direction parallel to the beam.

1607.13 Interior walls and partitions. Interior walls and partitions that exceed 6 feet (1829 mm) in height, including their finish materials, shall have adequate strength to resist the loads to which they are subjected but not less than a horizontal load of 5 psf (0.240 kN/m^2).

Exception: Fabric partitions complying with Section 1607.13.1 shall not be required to resist the minimum horizontal load of 5 psf (0.24 kN/m^2).

1607.13.1 Fabric partitions. Fabric partitions that exceed 6 feet (1829 mm) in height, including their finish materials, shall have adequate strength to resist the following load conditions:

1. A horizontal distributed load of 5 psf (0.24 kN/m^2) applied to the partition framing. The total area used to determine the distributed load shall be the area of the fabric face between the framing members to which the fabric is attached. The total distributed load shall be uniformly applied to such framing members in proportion to the length of each member.
2. A concentrated load of 40 pounds (0.176 kN) applied to an 8-inch diameter (203 mm) area [50.3 square inches (32 452 mm^2)] of the fabric face at a height of 54 inches (1372 mm) above the floor.

SECTION 1608
SNOW LOADS
RESERVED

SECTION 1609
WIND LOADS

1609.1 Applications. Buildings, structures and parts thereof shall be designed to withstand the minimum wind loads prescribed herein. Decreases in wind loads shall not be made for the effect of shielding by other structures.

All exterior wall coverings and soffits shall be capable of resisting the design pressures specified for walls for components and cladding loads in accordance with Section 1609.1.1.

1609.1.1 Determination of wind loads. Wind loads on every building or structure shall be determined in accordance with Chapter 6 of ASCE 7. The type of opening protection required, the basic wind speed and the exposure category for a site is permitted to be determined in accordance with Section 1609 or ASCE 7. Wind shall be assumed to come from any horizontal direction and wind pressures shall be assumed to act normal to the surface considered.

Note: Clarification to ASCE 7. Arrows shown on Figure 6-10 of ASCE 7 indicate that the pressure coefficients apply specifically to "Direction of MWFRS being designed." This means that the longitudinal pressure coefficients are not applicable to trusses that span in the transverse direction and, therefore, uplift reactions for trusses that span in the transverse direction would be determined by the pressure coefficients associated with those shown for the transverse direction.

Exceptions:

1. Wind tunnel tests together with applicable section 6.4 of ASCE 7.
2. Subject to the limitations of Sections 1609.1.1.1, 1609.1.2, and 1609.3, the provisions of *IBHS Guideline for Hurricane Resistant Residential Construction* shall be permitted for applicable Group R-2 and R-3 buildings for a basic wind speed of 140 mph (63 m/s) or less in Exposure B in accordance with Figure 1609 and Section 1609.4. Provisions for design wind speeds of 140 mph (63 m/s) in the Guideline shall also be permitted for buildings for a basic wind speed of 120 mph (54 m/s) or less in Exposure C in accordance with Figure 1609 and Section 1609.4 and provisions for design wind speeds of 120 mph (54 m/s) in the Guideline shall be permitted for buildings for a basic wind speed of 100 mph (45 m/s) or less in Exposure C in accordance with Figure 1609 and Section 1609.4.
3. Subject to the limitations of Sections 1609.1.1.1, 1609.1.2, and 1609.3, provisions of ANSI/AF&PA WFCM, *Wood Frame Construction Manual for One- and Two-Family Dwellings* shall be permitted for applicable wood frame buildings of Group R-3 occupancy for a basic

wind speed of 150 mph or less in accordance with Figure 1609 and Section 1609.4.

4. Designs using NAAMM FP-1001 *Specification for Design Loads of Metal Flagpoles*.
5. Subject to the limitations of Sections 1609.1.1.1, 1609.1.2, and 1609.3, the provisions of the FC&PA Guide to Concrete Masonry Residential Construction in High Wind Areas shall be permitted for applicable concrete masonry buildings of Group R-3 occupancy for a basic wind speed of 130 mph (58 m/s) or less in Exposure B and 110 mph (49 m/s) or less in Exposure C in accordance with Figure 1609 and Section 1609.4.
6. ANSI/TIA/EIA 222 shall be permitted for communication tower and steel antenna support structures and shall meet the wind loads of ASCE 7 and shall be designed by a qualified engineer.
7. Subject to the limitations of Sections 1609.1.1.1, 1609.1.2, and 1609.3, the provisions of the WPPC Guide to Wood Construction in High Wind Areas shall be permitted for applicable wood-frame buildings of Group R-3 occupancy for a basic wind speed of 130 mph (58 m/s) or less in Exposure B and 110 mph (49 m/s) or less in Exposure C in accordance with Figure 1609 and Section 1609.4.
8. Designs using AASHTO LTS-4 Structural Specifications for Highway Signs, Luminaires, and Traffic Signals.
9. Wind loads for screened enclosures shall be determined in accordance with Section 2002.4.

1609.1.1.1 Applicability. The provisions of IBHS *Guideline for Hurricane Resistant Residential Construction*, the AF&PA *Wood Frame Construction Manual for One- and Two-Family Dwellings, High Wind Areas*, the FC&PA *Guide to Concrete Masonry Residential Construction in High Wind Areas* and the WPPC *Guide to Wood Construction in High Wind Areas* are applicable only to buildings located within Exposure B or C as defined in Section 1609.4. The provisions of IBHS *Guideline for Hurricane Resistant Residential Construction*, the AF&PA *Wood Frame Construction Manual for One- and Two-Family Dwellings, High Wind Areas* and the WPPC *Guide to Wood Construction in High Wind Areas* shall not apply to buildings sited on the upper half of an isolated hill, ridge or escarpment meeting the following conditions:

1. The hill, ridge or escarpment is 60 feet (18 288 mm) or higher if located in Exposure B or 30 feet (9144 mm) or higher if located in Exposure C;
2. The maximum average slope of the hill exceeds 10 percent; and
3. The hill, ridge or escarpment is unobstructed upwind by other such topographic features for a distance from the high point of 50 times the height of the hill or 1 mile (1.61 km), whichever is greater.

1609.1.2 Protection of openings. In wind-borne debris regions, glazing in buildings shall be impact resistant or protected with an impact resistant covering meeting the requirements of SSTD 12, ASTM E 1886 and ASTM E 1996, ANSI/DASMA 115 (for garage doors and rolling doors) or Miami-Dade TAS 201, 202 and 203 or AAMA 506 referenced therein as follows:

1. Glazed openings located within 30 feet (9144 mm) of grade shall meet the requirements of the Large Missile Test.
2. Glazed openings located more than 30 feet (9144 mm) above grade shall meet the provisions of the Small Missile Test.
3. Storage sheds that are not designed for human habitation and that have a floor area of 720 square feet (67 m^2) or less are not required to comply with the mandatory wind-borne debris impact standards of this code.
4. Openings in sunrooms, balconies or enclosed porches constructed under existing roofs or decks are not required to be protected provided the spaces are separated from the building interior by a wall and all openings in the separating wall are protected in accordance with Section 1609.1.2. Such spaces shall be permitted to be designed as either partially enclosed or enclosed structures.

Exceptions:

1. Wood structural panels with a minimum thickness of $^7/_{16}$ inch (11.1 mm) and a maximum span of 8 feet (2438 mm) shall be permitted for opening protection in one- and two-story buildings. Panels shall be precut so that they shall be attached to the framing surrounding the opening containing the product with the glazed openings. Panels shall be predrilled as required for the anchorage method and all required hardware shall be provided. Attachment shall be designed to resist the components and cladding loads determined in accordance with the provisions of ASCE 7, with permanent corrosion-resistant attachment hardware provided and anchors permanently installed on the building. Attachment in accordance with Table 1609.1.2, with permanent corrosion resistant attachment hardware provided and anchors permanently installed on the building is permitted for buildings with a mean roof height of 45 feet (13 716 mm) or less where wind speeds do not exceed 140 mph (63 m/s)
2. Glazing in Occupancy Category I buildings as defined in Section 1604.5, including greenhouses that are occupied for growing plants on a production or research basis, without public access shall be permitted to be unprotected.
3. Glazing in Occupancy Category II, III or IV buildings located over 60 feet (18 288 mm) above the ground and over 30 feet (9144 mm) above aggregate surface roofs located within 1,500 feet (458

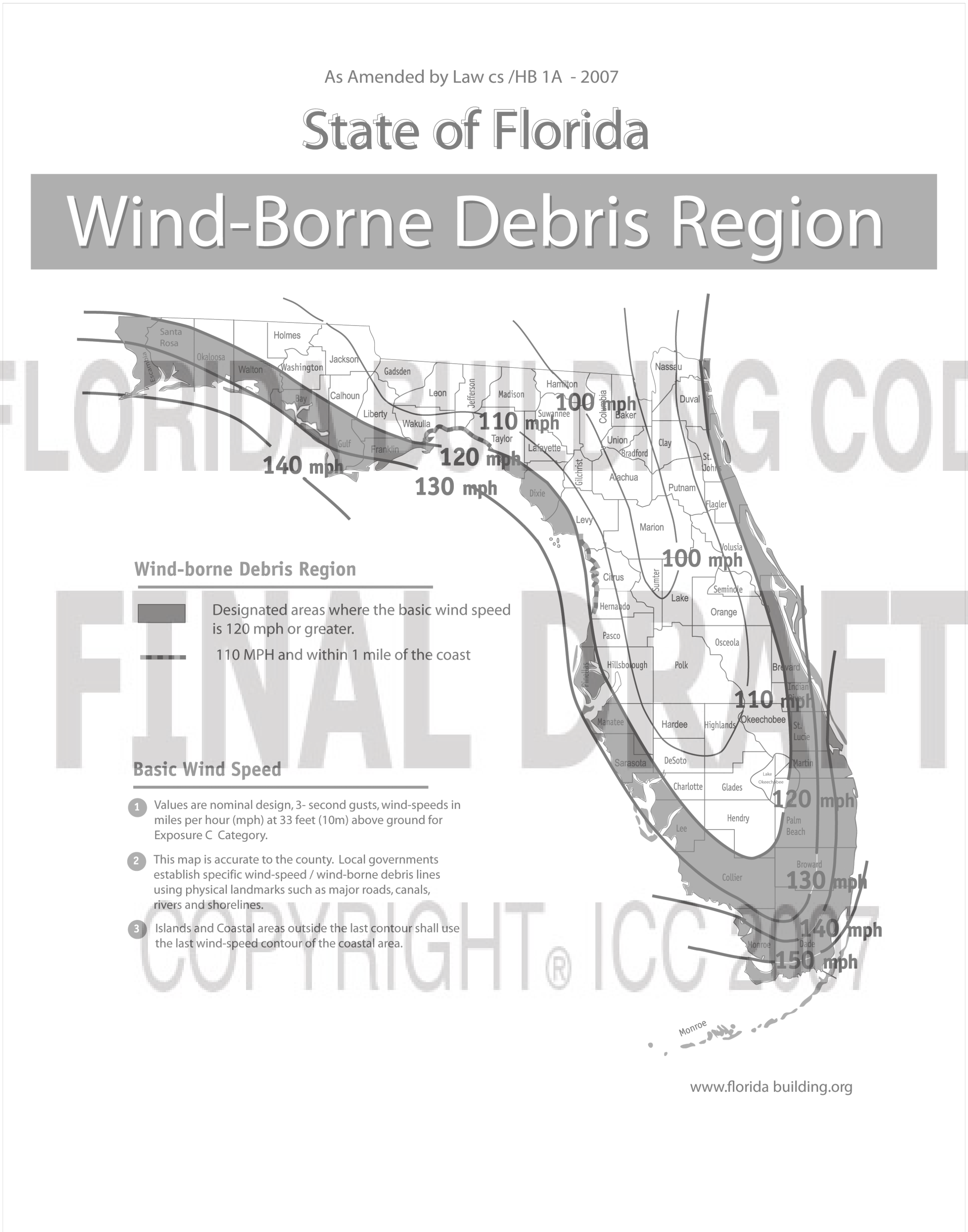


FIGURE 1609
STATE OF FLORIDA DEBRIS REGION & BASIC WIND SPEED

m) of the building shall be permitted to be unprotected.

TABLE 1609.1.2
WIND-BORNE DEBRIS PROTECTION FASTENING SCHEDULE FOR WOOD STRUCTURAL PANELS

FASTENER TYPE	FASTENER SPACING (inches)[1,2]			
	Panel Span ≤ 2 ft	2 foot < panel Span ≤ 4 feet	4 feet < Panel Span ≤ 6 feet	6 feet < Panel Span ≤ 8 feet
#8 Wood screw-based anchor with 2-inch embedment length[3]	16	16	10	8
#10 Wood screw-based anchor with 2-inch embedment length[3]	16	16	12	9
¼ Lag screw-based anchor with 2-inch embedment length[3]	16	16	16	16

For SI: 1 inch = 25.4 mm, 1 foot = 305 mm.

1. This table is based on a maximum wind speed of 140 mph (63 m/s) and mean roof height of 45 feet (13 716 mm) or less.
2. Fasteners shall be installed at opposing ends of the wood structural panel.
3. Where screws are attached to masonry or masonry/stucco, they shall be attached using vibration-resistant anchors having a minimum withdrawal capacity of 1500 lb (6673 kN).

1609.1.2.1 Louvers. Louvers protecting intake and exhaust ventilation ducts not assumed to be open that are located within 30 feet (9144 mm) of grade shall meet requirements of an approved impact-resisting standard or the Large Missile Test of ASTM E 1996.

1609.1.2.2 Impact resistant coverings.

1609.1.2.2.1 Impact resistant coverings shall be tested at 1.5 times the design pressure (positive or negative) expressed in pounds per square feet as determined by the *Florida Building Code, Building* Section 1609 for which the specimen is to be tested.

1609.1.2.2.2 Impact resistant coverings. Impact resistant coverings shall be labeled in accordance with the provisions of Section 1714.8.

1609.1.3 Optional exterior door component testing. Exterior side-hinged door assemblies shall have the option to have the components of the assembly tested and rated for impact resistance in accordance with the following specification: SDI 250.13.

1609.1.4 The wind-borne debris regions requirements shall not apply landward of the designated contour line in Figure 1609. A geographical boundary that coincides with the contour line shall be established.

1609.2 Definitions. The following words and terms shall, for the purposes of Section 1609, have the meanings shown herein.

HURRICANE-PRONE REGIONS. Areas vulnerable to hurricanes defined as:

1. The U. S. Atlantic Ocean and Gulf of Mexico coasts where the basic wind speed is greater than 90 mph (40 m/s) and
2. Hawaii, Puerto Rico, Guam, Virgin Islands and American Samoa.

WIND-BORNE DEBRIS REGION. Portions of hurricane-prone regions that are within 1 mile (1.61 km) of the coastal mean high water line where the basic wind speed is 110 mph (48 m/s) or greater; or portions of hurricane-prone regions where the basic wind speed is 120 mph (53 m/s) or greater; or Hawaii.

1609.3 Basic wind speed. The basic wind speed in miles per hour, for the development of wind loads, shall be determined from Figure1609. The exact location of wind speed lines shall be established by local ordinance using recognized physical landmarks such as major roads, canals, rivers and lake shores whenever possible.

1609.3.1 Wind speed conversion. When required, the 3-second gust basic wind speeds of Figure 1609 shall be converted to fastest-mile wind speeds, V_{fm}, using Table 1609.3.1 or Equation 16-34.

$$V_{fm} = \frac{(V_{3S} - 10.5)}{1.05} \qquad \textbf{(Equation 16-34)}$$

where:

V_{3S} = 3-second gust basic wind speed from Figure 1609.

1609.4 Exposure category. For each wind direction considered, an exposure category that adequately reflects the characteristics of ground surface irregularities shall be determined for the site at which the building or structure is to be constructed. Account shall be taken of variations in ground surface roughness that arise from natural topography and vegetation as well as from constructed features.

Exception: An intermediate exposure between the exposure categories defined is permitted in a transition zone, provided that it is determined by a rational analysis method.

1609.4.1 Wind directions and sectors. For each selected wind direction at which the wind loads are to be evaluated, the exposure of the building or structure shall be determined for the two upwind sectors extending 45 degrees (0.79 rad) either side of the selected wind direction. The exposures in these two sectors shall be determined in accordance with Sections 1609.4.2 and 1609.4.3 and the exposure resulting in the highest wind loads shall be used to represent winds from that direction.

1609.4.2 Surface roughness categories. A ground surface roughness within each 45-degree (0.79 rad) sector shall be determined for a distance upwind of the site as defined in Section 1609.4.3 from the categories defined below, for the purpose of assigning an exposure category as defined in Section 1609.4.3.

Surface Roughness B. Urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger.

Surface Roughness C. Open terrain with scattered obstructions having heights generally less than 30 feet (9144 mm). This category includes flat open country,

TABLE 1609.3.1
EQUIVALENT BASIC WIND SPEEDS[a,b,c]

V3S	85	90	100	105	110	120	125	130	140	145	150	160	170
Vfm	71	76	85	90	95	104	109	114	123	128	133	142	152

For SI: 1 mile per hour = 0.44 m/s.
a. Linear interpolation is permitted.
b. V_{3S} is the 3-second gust wind speed (mph).
c. V_{fm} is the fastest mile wind speed (mph).

grasslands, and all water surfaces in hurricane-prone regions.

Surface Roughness D. Reserved.

1609.4.3 Exposure categories. An exposure category shall be determined in accordance with the following:

Exposure B. Exposure B shall apply where the ground surface roughness condition, as defined by Surface Roughness B, prevails in the upwind direction for a distance of at least 2,600 feet (792 m) or 20 times the height of the building, whichever is greater.

Exception: For buildings whose mean roof height is less than or equal to 30 feet (9144 mm), the upwind distance is permitted to be reduced to 1,500 feet (457 m).

Exposure C. Open terrain with scattered obstructions, including surface undulations or other irregularities, having heights generally less than 30 feet (9144 mm) extending more than 1,500 feet (457.2 m) from the building site in any quadrant. This exposure shall also apply to any building located within Exposure B-type terrain where the building is within 100 feet horizontally in any direction of open areas of Exposure C-type terrain that extends more than 600 feet (182.9 m) and width greater than 150 ft. in the upwind direction. Short-term (less than two year) changes in the pre-existing terrain exposure, for the purposes of development, shall not be considered open fields. Where development buildout will occur within three years and the resultant condition will meet the definition of Exposure B, Exposure B shall be regulating for the purpose of permitting. This category includes flat open country, grasslands and ocean or gulf shorelines and shall extend downwind for a distance of 1500 feet. For buildings located within a distance of 600 feet of inland bodies of water that present a fetch of 1 mile (1.61 km) or more or inland waterways or rivers with a width of 1 mile (1.61 km) or more roof sheathing uplift and roof-to-wall uplift loads shall be increased by 20 percent.

Exposure D. This exposure category is not applicable in Florida.

1609.5 Roof systems.

1609.5.1 Roof deck. The roof deck shall be designed to withstand the wind pressures determined in accordance with ASCE 7.

1609.5.2 Roof coverings. Roof coverings shall comply with Section 1609.5.1.

Exception: Rigid tile roof coverings that are air permeable and installed over a roof deck complying with Section 1609.5.1 are permitted to be designed in accordance with Section 1609.5.3.

Asphalt shingles installed over a roof deck complying with Section 1609.5.1 shall be tested to determine the resistance of the sealant to uplift forces using ASTM D 6381.

Asphalt shingles installed over a roof deck complying with Section 1609.5.1 are permitted to be designed using UL 2390 to determine appropriate uplift and force coefficients applied to the shingle.

1609.5.3 Rigid tile. Wind loads on rigid tile roof coverings shall be determined in accordance with the following equation:

$$M_a = q_h C_L b L L_a [1.0 - GC_p] \quad \textbf{(Equation 16-35)}$$

For SI: $M_a = \dfrac{q_h C_L b L L_a \left[1.0 - GC_p\right]}{1{,}000}$

where:

b = Exposed width, feet (mm) of the roof tile.

C_L = Lift coefficient. The lift coefficient for concrete and clay tile shall be 0.2 or shall be determined by test in accordance with Section 1715.2.

GC_p = Roof pressure coefficient for each applicable roof zone determined from Chapter 6 of ASCE 7. Roof coefficients shall not be adjusted for internal pressure.

L = Length, feet (mm) of the roof tile.

L_a = Moment arm, feet (mm) from the axis of rotation to the point of uplift on the roof tile. The point of uplift shall be taken at 0.76L from the head of the tile and the middle of the exposed width. For roof tiles with nails or screws (with or without a tail clip), the axis of rotation shall be taken as the head of the tile for direct deck application or as the top edge of the batten for battened applications. For roof tiles fastened only by a nail or screw along the side of the tile, the axis of rotation shall be determined by testing. For roof tiles installed with battens and fastened only by a clip near the tail of the tile, the moment arm shall be determined about the top edge of the batten with consideration given for the point of rotation of the tiles based on straight bond or broken bond and the tile profile.

M_a = Aerodynamic uplift moment, feet-pounds (N-mm) acting to raise the tail of the tile.

q_h = Wind velocity pressure, psf (kN/m^2) determined from Section 6.5.10 of ASCE 7.

Concrete and clay roof tiles complying with the following limitations shall be designed to withstand the aerodynamic uplift moment as determined by this section.

1. The roof tiles shall be either loose laid on battens, mechanically fastened, mortar set or adhesive set.
2. The roof tiles shall be installed on solid sheathing which has been designed as components and cladding.
3. An underlayment shall be installed in accordance with Chapter 15.
4. The tile shall be single lapped interlocking with a minimum head lap of not less than 2 inches (51 mm).
5. The length of the tile shall be between 1.0 and 1.75 feet (305 mm and 533 mm).
6. The exposed width of the tile shall be between 0.67 and 1.25 feet (204 mm and 381 mm).
7. The maximum thickness of the tail of the tile shall not exceed 1.3 inches (33 mm).
8. Roof tiles using mortar set or adhesive set systems shall have at least two-thirds of the tile's area free of mortar or adhesive contact.

1609.6 Garage doors and rolling doors. Pressures from Table 1609.6(1) for wind loading actions on garage doors and rolling doors for buildings designed as enclosed shall be permitted.

SECTION 1610
SOIL LATERAL LOADS

1610.1 General. Basement, foundation and retaining walls shall be designed to resist lateral soil loads. Soil loads specified in Table 1610.1 shall be used as the minimum design lateral soil loads unless specified otherwise in a soil investigation report approved by the building official. Basement walls and other walls in which horizontal movement is restricted at the top shall be designed for at-rest pressure. Retaining walls free to move and rotate at the top are permitted to be designed for active pressure. Design lateral pressure from surcharge loads shall be added to the lateral earth pressure load. Design lateral pressure shall be increased if soils with expansion potential are present at the site.

Exception: Basement walls extending not more than 8 feet (2438 mm) below grade and supporting flexible floor systems shall be permitted to be designed for active pressure.

SECTION 1611
RAIN LOADS

1611.1 Design rain loads. Each portion of a roof shall be designed to sustain the load of rainwater that will accumulate on it if the primary drainage system for that portion is blocked plus the uniform load caused by water that rises above the inlet of the secondary drainage system at its design flow.

$$R = 5.2\,(d_s + d_h) \qquad \textbf{(Equation 16-36)}$$

For SI: $R = 0.0098\,(d_s + d_h)$

where:

d_h = Additional depth of water on the undeflected roof above the inlet of secondary drainage system at its design flow (i.e., the hydraulic head), in inches (mm).

d_s = Depth of water on the undeflected roof up to the inlet of secondary drainage system when the primary drainage system is blocked (i.e., the static head), in inches (mm).

R = Rain load on the undeflected roof, in psf (kN/m^2). When the phrase "undeflected roof" is used, deflections from loads (including dead loads) shall not be considered when determining the amount of rain on the roof.

1611.2 Ponding instability. For roofs with a slope less than $^1/_4$ inch per foot [1.19 degrees (0.0208 rad)], the design calculations shall include verification of adequate stiffness to preclude progressive deflection in accordance with Section 8.4 of ASCE 7.

1611.3 Controlled drainage. Roofs equipped with hardware to control the rate of drainage shall be equipped with a secondary drainage system at a higher elevation that limits accumulation of water on the roof above that elevation. Such roofs shall be designed to sustain the load of rainwater that will accumulate on them to the elevation of the secondary drainage system plus the uniform load caused by water that rises above the inlet of the secondary drainage system at its design flow determined from Section 1611.1. Such roofs shall also be checked for ponding instability in accordance with Section 1611.2.

SECTION 1612
HIGH-VELOCITY HURRICANE ZONES—GENERAL

1612.1 General design requirements.

1612.1.1 Any system, method of design or method of construction shall admit of a rational analysis in accordance with well-established principles of mechanics and sound engineering practices.

1612.1.2 Buildings, structures and all parts thereof shall be designed and constructed to be of sufficient strength to support the estimated or actual imposed dead, live, wind, and any other loads, both during construction and after completion of the structure, without exceeding the allowable materials stresses specified by this code.

1612.1.3 No building structure or part thereof shall be designed for live loads less than those specified in this Chapter or ASCE 7 with commentary, except as otherwise noted in this code.

1612.1.4 The live loads set forth herein shall be assumed to include the ordinary impact but where loading involves unusual impact, provision shall be made by increasing the assumed live load.

TABLE 1609.6(1)
GARAGE DOOR AND ROLLING DOOR WIND LOADS FOR A BUILDING WITH A MEAN ROOF HEIGHT OF 30 FEET LOCATED IN EXPOSURE B (psf)

EFFECTIVE WIND AREA		Basic Wind Speed V (mph - 3 second gust)															
Width (ft)	Height (ft)	85		90		100		110		120		130		140		150	
Roof Angle 0 - 10 degrees																	
8	8	10.5	-11.9	11.7	-13.3	14.5	-16.4	17.5	-19.9	20.9	-23.6	24.5	-27.7	28.4	-32.2	32.6	-36.9
10	10	10.1	-11.4	11.4	-12.7	14.0	-15.7	17.0	-19.0	20.2	-22.7	23.7	-26.6	27.5	-30.8	31.6	-35.4
14	14	10.0	-10.7	10.8	-12.0	13.3	-14.8	16.1	-17.9	19.2	-21.4	22.5	-25.1	26.1	-29.1	30.0	-33.4
Roof Angle > 10																	
9	7	11.4	-12.9	12.8	-14.5	15.8	-17.9	19.1	-21.6	22.8	-25.8	26.7	-30.2	31.0	-35.1	35.6	-40.2
16	7	10.9	-12.2	12.3	-13.7	15.2	-16.9	18.3	-20.4	21.8	-24.3	25.6	-28.5	29.7	-33.1	34.1	-38.0

For SI: 1 Square foot = 0.929 m^2, 1 mph = 0.447 m/s, 1 psf = 47.88 N/m^2

1. For effecctive areas or wind speeds between those given above the load may be interpolated, otherwise use the load associated with the lower effective area.
2. Table values shall be adjusted for height and exposure by multiplying by adjustment coefficients in Table 1609.6(2).
3. Plus and minus signs signify pressures acting toward and away from the building surfaces.
4. Negative pressures assume door has 2 feet of width in building's end zone.

TABLE 1609.6(2)
ADJUSTMENT FACTOR FOR BUILDING HEIGHT AND EXPOSURE, (λ)

MEAN ROOF HEIGHT (feet)	EXPOSURE		
	B	C	D
15	1.00	1.21	1.47
20	1.00	1.29	1.55
25	1.00	1.35	1.61
30	1.00	1.40	1.66
35	1.05	1.45	1.70
40	1.09	1.49	1.74
45	1.12	1.53	1.78
50	1.16	1.56	1.81
55	1.19	1.59	1.84
60	1.22	1.62	1.87

For SI: 1 foot = 304.8 mm.

a. All table values shall be adjusted for other exposures and heights by multiplying by the above coefficients.

TABLE 1610.1
SOIL LATERAL LOAD

DESCRIPTION OF BACKFILL MATERIAL[c]	UNIFIED SOIL CLASSIFICATION	DESIGN LATERAL SOIL LOAD[a] (pound per square foot per foot of depth)	
		Active pressure	At-rest pressure
Well-graded, clean gravels; gravel-sand mixes	GW	30	60
Poorly graded clean gravels; gravel-sand mixes	GP	30	60
Silty gravels, poorly graded gravel-sand mixes	GM	40	60
Clayey gravels, poorly graded gravel-and-clay mixes	GC	45	60
Well-graded, clean sands; gravelly sand mixes	SW	30	60
Poorly graded clean sands; sand-gravel mixes	SP	30	60
Silty sands, poorly graded sand-silt mixes	SM	45	60
Sand-silt clay mix with plastic fines	SM-SC	45	100
Clayey sands, poorly graded sand-clay mixes	SC	60	100
Inorganic silts and clayey silts	ML	45	100
Mixture of inorganic silt and clay	ML-CL	60	100
Inorganic clays of low to medium plasticity	CL	60	100
Organic silts and silt clays, low plasticity	OL	Note b	Note b
Inorganic clayey silts, elastic silts	MH	Note b	Note b
Inorganic clays of high plasticity	CH	Note b	Note b
Organic clays and silty clays	OH	Note b	Note b

For SI: 1 pound per square foot per foot of depth = 0.157 kPa/m, 1 foot = 304.8 mm.

a. Design lateral soil loads are given for moist conditions for the specified soils at their optimum densities. Actual field conditions shall govern. Submerged or saturated soil pressures shall include the weight of the buoyant soil plus the hydrostatic loads.

b. Unsuitable as backfill material.

1612.1.5 In the design of floors, not less than the actual live load to be imposed shall be used. Special provisions shall be made for machine or apparatus loads where applicable.

1612.1.6 Floor and roof systems shall be designed and constructed to transfer horizontal forces to such parts of the structural frame as are designed to carry these forces to the foundation. Where roofs or floors are constructed of individual prefabricated units and the transfer of forces to the building frame and foundation is totally or partially dependent on such units, the units and their attachments shall be capable of resisting applied loads in both vertical and both horizontal directions. Where roofs or floors are constructed of individual prefabricated units and the transfer of forces to the building frame and foundation is wholly independent of such units, the units and their attachments shall be capable of resisting applied loads normal to the surface, in and out..

1612.2 General design for specific occupancies and structures.

1612.2.1 Fences. Fences not exceeding 6 feet (1829 mm) in height from grade may be designed for 75 mph (33 m/s) fastest mile wind speed or 90 mph (40 m/s) 3-second gust.

1612.2.1.1 Wood fences. Wood fence design shall be as specified by Section 2328.

1612.2.2 Sway forces in stadiums.

1. The sway force applied to seats in stadiums, grandstands, bleachers and reviewing stands shall be not less than 24 pounds per lineal foot (350 N/m), applied perpendicularly and along the seats.
2. Sway forces shall be applied simultaneously with gravity loads.
3. Sway forces need not be applied simultaneously with other lateral forces.

SECTION 1613
HIGH-VELOCITY HURRICANE ZONES—DEFLECTION

1613.1 Allowable deflections. The deflection of any structural member or component when subjected to live, wind and other superimposed loads set forth herein shall not exceed the following:

1. Roof and ceiling or components supporting plaster L/360
2. Roof members or components not supporting plaster under L/240

3. Floor members or components L/360
4. Vertical members and wall members or components consisting of or supporting material that hardens in place, is brittle or lacks resistance to cracking caused by bending strains L/360
5. Vertical members and wall members or components not required to meet the conditions of Section 1613.1, item 4. . . . . L/180
6. Roof and vertical members, wall members and panels of carports, canopies, marquees, patio covers, utility sheds and similar minor structures not to be considered living areas, where the roof projection is greater than 12 feet (3.7 m) in the direction of the span, for free-standing roofs and roofs supported by existing structures. Existing structures supporting such roofs shall be capable of supporting the additional loading L/180
7. For Group R3 occupancies only, roof and vertical members, wall members and panels of carports, canopies, marquees, patio covers, utility sheds and similar minor structures not to be considered living areas, where the roof projection is 12 feet (3.7 m) or less in the direction of the span and for free standing roofs and roofs supported by existing structures L/80
8. Members supporting screens only L/80
9. Storm shutters and fold-down awnings, which in the closed position shall provide a minimum clear separation from the glass of 1 inch (25 mm) but not to exceed 2 inches (51 mm) when the shutter or awning is at its maximum point of permissible deflection L/30
10. Roofs and exterior walls of utility sheds having maximum dimensions of 10 feet (3 m) length, 10 feet (3 m) width, and 7 feet (2.1 m) height L/80
11. Roofs and exterior walls of storage buildings larger than utility sheds L/180

SECTION 1614
HIGH-VELOCITY HURRICANE ZONES— VOLUME CHANGES

1614.1 Volume change. In the design of any building, structure or portion thereof, consideration shall be given to the relief of stresses caused by expansion, contraction and other volume changes.

SECTION 1615
HIGH-VELOCITY HURRICANE ZONES— MINIMUM LOADS

1615.1 Live loads. Minimum uniformly distributed live loads shall not be less than as set forth in and Table 4-1 of ASCE 7 with commentary, except as otherwise noted in this code.

1615.2 Concentrated loads. Minimum concentrated loads shall not be less than as set forth in Table 4-1 of ASCE 7 with commentary, except as otherwise noted.

1615.2.1 Concentrated loads on trusses. Any single panel point of the lower chord of roof trusses or any point of other primary structural members supporting roofs over manufacturing, commercial storage and warehousing, and commercial garage floors shall be capable of safely carrying a suspended, concentrated load of not less than 2,000 pounds (8896 N) in addition to dead load. For all other occupancies, a minimum load of 200 pounds (890 N) shall be used.

TABLE 1615
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS
See Tables 4-1 of ASCE 7 with commentary, except as otherwise noted below

OCCUPANCY OR USE	LIVE LOAD POUNDS PER SQUARE FOOT
Assembly projection room	100
Balconies, Exterior (see also assembly) Serving private units of Group R occupancies and not for assembly use	60
Balconies serving occupancies 80 psf or less	80
All other balconies	100
Cabanas and bath house	50
Path of egress servicing occupancies 80 psf or less	80
Path of egress servicing occupancies over 80 psf	100
Recreational facilities Including bowling centers, pool rooms and similar uses	75
Storage: Light Medium Heavy	 75 125 250[1,2]

For SI: 1 pound per square foot = 47.88 Pa.
1. Use actual equipment weight when greater.
2. Increase when occupancy exceeds this amount.

SECTION 1616
HIGH-VELOCITY HURRICANE ZONES— ROOF LIVE LOADS

1616.1 Minimum roof live loads. Roofs shall be designed for a live load of not less than 30 psf (1436 Pa), except as set forth herein.

Exceptions:

1. Glass areas of greenhouse roofs shall be designed for a live load of not less than 15 psf (718 Pa).
2. Ordinary pitched and curved roofs, with a slope of $1^1/_2$:12, or greater, where water is not directed to the interior of the roof, without parapet or other edge of roof drainage obstructions, may be designed for an allowable live load of not less than 20 psf (958 Pa).
3. Utility sheds shall be designed for a live load of not less than 15 psf (718 Pa).

1616.2 Special purpose roofs. Roofs used for assembly, roof gardens, promenade or walkway purposes shall be designed for a minimum live load of 100 psf (4788 Pa). Other special purpose roofs shall be designed for appropriate loads as directed or approved by the building official.

1616.3 Roof decking. Roof decking shall be designed to support the live load set forth in 1616.1 or a load of 100 pounds per foot (445 N) applied as a 1 foot (305 mm) wide strip perpendicular to, and at the center of, the span of the decking between supports, whichever is more critical.

SECTION 1617
HIGH-VELOCITY HURRICANE ZONES—
ROOF DRAINAGE

1617.1 Roof drainage. Where parapets or curbs are constructed above the level of the roof, provision shall be made to prevent rain water from accumulating on the roof in excess of that considered in the design, in the event the rain water drains, conductors or leaders become clogged.

1617.2 Where roofs are not designed in accordance with Section 1617.1, overflow drains or scuppers shall be placed to prevent an accumulation of more than 5 inches (927 mm) of water on any portion of the roof. In determining the load that could result should the primary drainage system be blocked, the loads caused by the depth of water (i.e., head) needed to cause the water to flow out the scuppers or secondary drainage system shall be included.

1617.3 Drains or scuppers installed to provide overflow drainage shall be not less in aggregate area than as shown in Figure 1617.3, but not less than 4 inches (102 mm) dimension in any direction and shall be placed in parapets not less than 2 inches (51 mm) nor more than 4 inches (102 mm) above the low point of the finished roofing surface and shall be located as close as practical to required vertical leaders, conductors or downspouts. The roof area to be taken in the sizing of the scuppers is the horizontal projection, except that, where a building wall extends above the roof in such a manner as to drain into the area considered, the one-half of the area of the vertical wall shall be added to the horizontal projection.

1617.4 All roofs shall be designed with sufficient slope or camber to assure adequate drainage after the long term deflection from dead load, or shall be designed to support maximum loads including possible ponding of water caused by deflection.

1617.5 Ponding loads. Roofs shall be designed to preclude instability from ponding loads.

1617.6 Each portion of a roof shall be designed to sustain the loads of all rainwater that could accumulate on it if the primary drainage system for that portion is obstructed. Ponding instability shall be considered in this situation. If the overflow drainage provisions contain drain lines, such lines shall be independent of any primary drain lines.

SECTION 1618
HIGH-VELOCITY HURRICANE ZONES—
SPECIAL LOAD CONSIDERATIONS

1618.1 Floors. In the design of floors, consideration shall be given to the effect of known or probable concentration of loads, partial concentrations of loads, partial load, vibratory, transitory, impact and machine loads. Design shall be based on the load or combination of loads that produces the higher stresses.

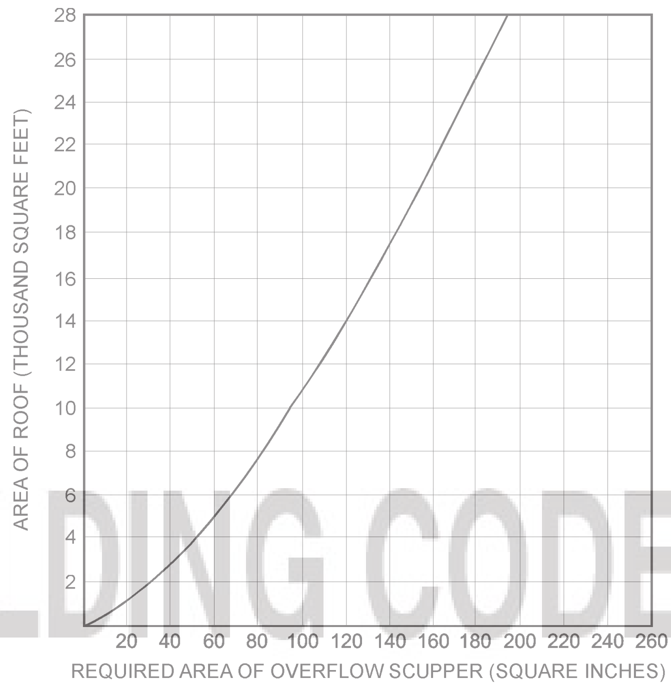


FIGURE 1617.3
REQUIRED AREA OF OVERFLOW SCUPPERS

1618.2 Below grade structures.

1618.2.1 In the design of basements, tanks, swimming pools and similar below grade structures, provisions shall be made for the forces resulting from hydrostatic pressure and lateral pressure of adjacent soil.

1618.2.2 For the lateral loads of soil on below grade structures, unless substantiated by more specific information, the angle of repose of fragmental rock and natural confined sand shall be 30 degrees and the angle of repose of filled soil and muck shall be 15 degrees to a horizontal line.

1618.2.3 For the hydrostatic pressure on any floor below a ground water level, calculations shall be based on full hydrostatic pressure, and such floors shall be designed for live load without hydrostatic uplift, and hydrostatic uplift without live load.

1618.2.4 Private swimming pools may be designed with an approved hydrostatic relief valve or other device capable of preventing the pool water from being pumped to a level lower than the surrounding ground water but such device shall not be credited for more than 2 feet (610 mm) of the difference of head between the pool bottom and the flood criteria.

1618.3 Helistops/heliports. In addition to other design requirements of this chapter, heliport and helistop loading or touchdown areas shall be designed for the maximum stress induced by the following:

1. Dead load plus actual weight of the helicopter.

2. Dead load plus two single concentrated impact loads approximately 8 feet (2.4 m) apart anywhere on the touchdown pad (representing each of the helicopter's two main landing gear, whether skid type or wheeled type), with each concentrated load covering 1 square foot (0.09 m^2) and having a minimum magnitude of 0.75 times the gross weight of the helicopter. Both loads acting together total a minimum of 1.5 times the gross weight of the helicopter.
3. The dead load plus a uniform live load of 60 psf (2873 Pa).

1618.4 Safeguards. Safeguards shall be required in and around buildings and structures such as covers, railings, stair-railings, handrails or other safeguards as defined in the regulations of the Occupational Safety and Health Administration (OSHA) 29 CFR Part 1910 as applied to permanent structures and as specified herein.

1618.4.1 Open or glazed wall openings; open or glazed sides of balconies, landings and other walking surfaces; unenclosed floor and roof openings; roofs used for other than services for the building or structure and any other abrupt differences in level exceeding 30 inches (762 mm), including yard areas, shall be provided with safeguards not less than 42 inches (1067 mm) in height.

1618.4.2 Safeguards may be omitted at loading docks, truck wells and similar locations where it is apparent that the edge of the higher level is for loading, and on docks, seawalls and decorative fountains where the lower level is the water surface.

1618.4.3 Safeguards in and around buildings of other than Group R occupancies shall be provided with additional rails, vertical pickets or ornamental filler below the top rail that will reject a 6-inch (152 mm) diameter object.

1618.4.4 Safeguards in and around buildings of Group R occupancies shall provide protection for children by providing additional rails, vertical pickets or an ornamental filler below the top rail which will reject a 4-inch (102 mm) diameter object; permitting, however, such ornamental fillers to have individual openings not exceeding 64 square inches (.04 m^2) in area.

1618.4.5 Where a balustrade is used to comply with the requirements of this paragraph, the maximum clearance between the bottom rail of the balustrade and the adjacent surface shall not exceed 2 inches (51 mm). For safeguards on stairs, the 2-inch (51 mm) clearance shall be measured from the bottom rail of the balustrade to a line passing through the tread nosings.

1618.4.6 Railing.

1618.4.6.1 Railings, stair-railings and other similar safeguards shall be designed to resist a load of 50 pounds per lineal foot (74 kg/m) or a concentrated load of 200 pounds (690 N) applied in any direction at the top of such barriers at any location on the safeguard, whichever condition produces the maximum stresses. The reactions and stresses caused by the above referenced uniform and concentrated loads shall be considered not be acting simultaneously.

1618.4.6.2 Intermediate rails, balusters and panel fillers shall be designed for a uniform horizontal load of not less than 25 psf (1197 Pa) over the gross area of the guard, including the area of any openings in the guard, of which they are a part without restriction by deflection. Reactions resulting from this loading need not be added to the loading specified in Section 1618.4.6.1 in designing the main supporting members of guards.

1618.4.6.3 Safety glazing will be permitted as an equal alternate to pickets, if tested by an accredited laboratory to satisfy the resistance requirements of this code for wind, live and kinetic energy impact loading conditions. The kinetic energy impact loading shall comply with ANSI Z97.1 using a 400 foot-pound (542 N) energy impact. The safety requirements of the impact test shall be judged to have been satisfactorily met if breakage does not occur or numerous cracks and fissures occur but no shear or opening through which a 3-inch (76 mm) diameter sphere may freely pass. The glass panel shall remain within the supporting frame.

1618.4.6.4 If the posts that support the top rail of exterior railings are substituted with glass, the assembly shall be tested to TAS 201, where the impacted glass continues to support the top rail and all applicable loads after impact.

1618.4.7 Areas in all occupancies from which the public is excluded requiring such protection may be provided with vertical barriers having a single rail midway between a top rail and the walking surface.

1618.4.8 The last sentence of the first paragraph in Section 4.4.2 of ASCE 7 is hereby deleted.

1618.5 Vehicle safeguard barriers. Vehicle safeguard barriers are required in parking garages whenever there is a difference in level exceeding 1 foot (305 mm).

1618.5.1 Unless separate pedestrian safeguards are provided vehicle safeguard barriers shall, in addition to the requirements of this section, meet all other requirements of Section 1618.4.

1618.5.2 The requirement of Section 1618.4.3 for the rejection of a 6-inch (152 mm) diameter object shall be met when the barrier is subjected to a horizontal load of 25 psf (1197 Pa), applied as specified in Section 1618.4.6.2.

1618.5.3 Vehicle safeguard barriers shall be capable of resisting a minimum horizontal ultimate load of 10,000 pounds (44.5 kN) applied 18 inches (457 mm) above the floor at any point in the barrier system. This load need not be applied in combination with loads specified in Section 1618.4.6.1 and Section 1618.4.6.2. Vehicle safeguard barrier systems of metal framing, concrete or masonry may be designed by allowable stress design for a concentrated horizontal load of 7,500 pounds (33 361 N) in lieu of the 10,000 pounds (44.5 kN) ultimate load specified above.

1618.6 Special requirements for cable safeguard barriers.

1618.6.1 Horizontal deflection under design load shall not exceed 18 inches (457 mm).

1618.6.2 The design load shall be assumed to be resisted by not more than two cables.

1618.6.3 The cable system including anchors shall be protected against corrosion.

1618.6.4 Cable tension under design load shall not exceed 90 percent of the yield strength of the cable.

1618.6.5 The uppermost cable shall be at least 42 inches (1067 mm) above the adjacent surface. Cables shall not be spaced more than 6 inches (152 mm) apart.

1618.6.6 An installation plan prepared by the structural engineer of record shall be submitted to the building official for his or her approval.

1618.6.7 Installation shall be witnessed by the structural engineer of record who shall certify the following:

1. That the installation has been in accordance with the approved installation plan.
2. That the initial tension designated by the structural engineer of record has been provided in all cables.
3. That all anchors have been seated at a total load, including initial tension, equal to 85 percent of the yield strength of the cable, unless a positive locking device is provided that does not require a tension jack for the tensioning of the barrier strand.

1618.6.8 Drawings shall indicate the initial tension, the expected increase in tension under vehicular impact and the required maximum capacity of the strand barrier system.

1618.7 Ornamental projections. Ornamental cantilevered projections on the exterior of buildings shall be designed for not less than 60 psf live load (2873 Pa) or 200 pounds per lineal foot (2919 N/m) applied at the outer edge, whichever is more critical.

1618.8 Interior wall and partitions. Permanent, full-height interior walls and partitions shall be designed to resist a lateral live load not less than 5 psf (239 Pa) and if sheathed with lath and plaster, deflection at this load shall not exceed L/360.

1618.9 Load combination. The safety of structures shall be checked using the provisions of 2.3 and 2.4 of ASCE 7 with commentary.

Exception: Increases in allowable stress shall be permitted in accordance with ACI 530/ASCE 5/TMS 402 provided the load reduction factor of 0.75 of combinations 4 and 6 of ASCE 7 Section 2.4.1 shall not be applied.

SECTION 1619
HIGH VELOCITY HURRICANE ZONES — LIVE LOAD REDUCTIONS

1619.1 Application. No reduction in assumed live loads set forth in this section shall be allowed in the design of columns, walls, beams, girders and foundations, except as permitted by the provisions of Section 4.8 ASCE 7 with commentary.

Exceptions:

1. No reduction of the assumed live loads shall be allowed in the design of any slabs, joists or other secondary members, except as set forth herein.
2. No reduction in roof live loads shall be permitted except as set forth by Section 1616.1.

1619.2 Allowable live load reductions.

1619.2.1 Permissible reduction in live loads shall be as provided in Section 4.8.1 of ASCE 7 with commentary.

1619.2.2 Limitations on live load reduction shall be as noted in Section 4.8.2 of ASCE 7 with commentary.

1619.2.3 No reduction in live loads shall be permitted for buildings or structures of Group A assembly occupancy.

SECTION 1620
HIGH-VELOCITY HURRICANE ZONES— WIND LOADS

1620.1 Buildings and structures, and every portion thereof, shall be designed and constructed to meet the requirements of Section 6 of ASCE 7, as more specifically defined in this section, based on a 50-year mean recurrence interval.

1620.2 Wind velocity (3-second gust) used in structural calculations shall be 140 miles per hour (63 m/s) in Broward County and 146 miles per hour (65 m/s) in Miami-Dade County.

1620.3 All buildings and structures shall be considered to be in Exposure Category C as defined in Section 6.5.6.3 of ASCE 7.

1620.4 For wind force calculations, roof live loads shall not be considered to act simultaneously with the wind load.

1620.5 Utility sheds shall be designed for a wind load of not less than 15 psf (718 Pa).

SECTION 1621
HIGH-VELOCITY HURRICANE ZONES— OVERTURNING MOMENT AND UPLIFT

1621.1 Computations for overturning moment and uplift shall be based on ASCE 7.

1621.2 Overturning and uplift stability of any building, structure or part thereof taken as a whole shall be provided, and shall be satisfied by conforming to the load combination requirements of ASCE 7.

SECTION 1622
HIGH-VELOCITY HURRICANE ZONES— SCREEN ENCLOSURES

1622.1 Screen enclosures.

1622.1.1 The wind loads on screen surfaces shall be per ASCE 7 Table 6-12 based on the ratio of solid to gross area.

1622.1.2 Design shall be based on such loads applied horizontally inward and outward to the walls with a shape factor of 1.3 and applied vertically upward and downward on the roof with a shape factor of 0.7.

SECTION 1623
HIGH-VELOCITY HURRICANE ZONES—
LIVE LOADS POSTED AND OCCUPANCY PERMITS

1623.1 Live loads posted. The live loads in every building, structure or part thereof of Group F, M or S Storage occupancy approved by the building official shall be shown on plates supplied by the owner or his authorized agent, in that part of each space to which such loads apply.

1623.1.1 Such plates shall be of approved durable materials displaying letters and figures not less than $^3/_8$ inch (9.5 mm) in height, and shall be securely affixed to the structure in conspicuous places.

1623.1.2 Such notices shall not be removed or defaced and where defaced, removed or lost, it shall be the responsibility of the owner to cause replacement as soon as possible.

1623.2 Occupant loads. Plans for proposed buildings or structures of Group F, M or S storage occupancy areas in buildings of any occupancy shall show the allowable loading for each portion of the floor and roof areas and certificates of use and occupancy, as defined in Section 110 of this code, shall not be issued until such loads are posted as set forth in Section 1623.1.

1623.2.1 Change in occupant load. No change in the occupancy of any building shall be made until a certificate of occupancy has been issued certifying that the building official has approved the building as suitable for the loads characteristic of the proposed occupancy.

1623.2.2 Maximum floor and roof loads observed. It shall be unlawful at any time to place, or permit to be placed, on any floor or roof of a building or structure, a load greater than that for which the floor or roof is approved by the building official.

SECTION 1624
HIGH-VELOCITY HURRICANE ZONES—
FOUNDATION DESIGN

1624.1 Design procedure. The minimum area of a footing or number of piles under a foundation shall be determined in the following manner:

1624.1.1 The total load of the column that has the largest percentage of the live load to the total load shall be divided by the allowable soil pressure or pile capacity.

1624.1.2 The balance soil pressure or pile capacity shall be determined by dividing the total dead load by the area of the footing or the number of piles.

1624.1.3 The minimum area of other footings or number of piles shall be designed on the basis of their respective dead loads only.

1624.1.4 In no case shall the total load of the combined dead, live, wind and any other loads exceed the allowable bearing pressure of the soil for capacity of any pile upon which the foundation is supported.

1624.1.5 The live load used in the above calculations may be the total reduced live load in the member immediately above the foundation.

1624.1.6 The building official may require submittal of design computations employed in foundation design.

1624.2 Wind effects. Reserved.

1624.2.1 Reserved.

SECTION 1625
HIGH-VELOCITY HURRICANE ZONES—
LOAD TESTS

1625.1 Application. Whenever there is insufficient evidence of compliance with the provisions of this code or evidence that any material or any construction does not conform to the requirements of this code, or in order to substantiate claims for alternate materials or methods of construction, the building official may require testing by an approved agency, at the expense of the owner or his agent, as proof of compliance. Testing methods shall be as specified by this code for the specific material.

1625.2 Testing method. Such testing shall follow a nationally recognized standard test, or when there is no standard test procedure for the material or assembly in question, the building official shall require the material or assembly under dead plus live load shall deflect not more than as set forth in Section 1613, and that the material or assembly shall sustain dead load plus twice the live load for a period of 24 hours, with a recovery of at least 80 percent or a 100 percent recovery after one-half test load.

1625.3 Alternate test methods. When elements, assemblies or details of structural members are such that their load-carrying capacity, deformation under load, or deflection cannot be calculated by rational analysis, their structural performance shall be established by test in accordance with test procedures as approved by the building official based on consideration of all probable conditions of loading.

1625.4 Fatigue load testing. Where cladding assemblies (including cladding and connections) or roofing framing assemblies (including portions of roof structure and connections) are such that their load-carrying capacity or deformation under load cannot be calculated by rational analysis, the assemblies may be tested to resist the fatigue loading sequence given by Table 1625.4.

TABLE 1625.4
FATIGUE LOADING SEQUENCE

RANGE OF TEST	NUMBER OF CYCLES[1]
0 to 0.5p[2]	600
0 to 0.6p	70
0 to 1.3p	1

1. Each cycle shall have minimum duration of 1 second and a maximum duration of 3 seconds and must be performed in a continuous manner.
2. p = the design wind load for the height and location, when the assembly will be used. For wall and roof components, shape factors given in ASCE 7 shall be used.

Assemblies shall be tested with no resultant failure or distress and shall have a recovery of at least 90 percent over maximum deflection.

Any cladding assembly not incorporated into the *Florida Building Code, Building* after successfully completing the impact test outlined in Section 1626, shall be subject to fatigue loading testing and shall obtain product approval by the building official.

SECTION 1626
HIGH-VELOCITY HURRICANE ZONES—IMPACT TESTS FOR WIND-BORNE DEBRIS

1626.1 All parts or systems of a building or structure envelope such as, but not limited, to exterior walls, roof, outside doors, skylights, glazing and glass block shall meet impact test criteria or be protected with an external protection device that meets the impact test criteria. Test procedures to determine resistance to wind-borne debris of wall cladding, outside doors, skylights, glazing, glass block, shutters and any other external protection devices shall be performed in accordance with this section.

Exception: The following structures or portion of structures shall not be required to meet the provisions of this section:

a. Roof assemblies for screen rooms, porches, canopies, etc. attached to a building that do not breach the exterior wall or building envelope and have no enclosed sides other than screen.

b. Soffits, soffit vents and ridge vents. Size and location of such vents shall be detailed by the designer and shall not compromise the integrity of the diaphragm boundary.

c. Vents in a garage with four or fewer cars. Size and location of such vents shall be detailed by the designer and shall not exceed the minimum required area by more than 25 percent.

d. Exterior wall or roof openings for wall- or roof-mounted HVAC equipment.

e. Openings for roof-mounted personnel access roof hatches.

f. Storage sheds that are not designed for human habitation and that have a floor area of 720 square feet (67 m^2) or less are not required to comply with the mandatory windborne debris impact standards of this code.

g. Louvers as long as they properly considered ASCE 7 in the design of the building.

h. Buildings and structures for marinas, cabanas, swimming pools, solariums and greenhouses.

1626.2 Large missile impact tests.

1626.2.1 This test shall be conducted on three test specimens. This test shall be applicable to the construction units, assemblies and materials to be used up to and including 30 feet (9.1 m) in height in any and all structures.

1626.2.2 The test specimens shall consist of the entire assembled unit, including frame and anchorage as supplied by the manufacturer for installation in the building, or as set forth in a referenced specification, if applicable. Fasteners used in mounting the test specimen shall be identical in size and spacing to what is used in field installations.

1626.2.3 The large missile shall be comprised of a piece of timber having nominal dimensions of 2 inches by 4 inches (51 mm by 102 m) weighing 9 pounds (4.1 kg).

1626.2.4 The large missile shall impact the surface of each test specimen at a speed of 50 feet per second (15.2 m/s).

1626.2.5 Each test specimen shall receive two impacts except as noted in Sections 1626.2.5.1 and 1626.2.5.2, the first within a 5-inch (127 mm) radius circle having its center on the midpoint of the test specimen and the second within a 5-inch (127 mm) radius circle in a corner having its center in a location 6 inches (152 mm) away from any supporting members.

1626.2.5.1 For window, glass block, fixed glass and skylight assemblies, both impacts shall be to glass or other glazing infill. For test specimens with more than one light of glass, a single light closest to the center of the assembly shall be selected and impacted twice in accordance with Section 1626.2.5. If a light of glass is sufficiently small to cause the 5-inch (127 mm) radius circle to overlap, two separate lights shall be impacted one time each.

1626.2.5.1.1 For window, fixed glass and skylight assemblies comprised of different glass thickness, types of glass or different types of glazing infill, each separate thickness or type shall be impacted twice in accordance with Section 1626.2.5.

1626.2.5.2 For doors, wall cladding and external protection devices, both impacts shall be to the thinnest section through the assembly. For doors, wall cladding and external protection devices with horizontal and/or vertical bracing, both impacts shall be within a single area that is not reinforced and shall be in accordance with Section 1626.2.5.

1626.2.5.2.1 For doors with glass, the glass shall be impacted twice and the thinnest section through the assembly that is not glass shall be impacted twice in accordance with Section 1626.2.5.

1626.2.6 In the case of glazing, if the three test specimens that comprise a test successfully reject the two missile impacts, they shall then be subjected to the cyclic pressure loading defined in Table 1626.

1626.2.6.1 If external protection devices are employed to protect windows, fixed doors or skylights, they must resist the large missile impacts specified in Sections 1626.2.3 and 1626.2.4 without deformations which result in contact with the windows, fixed glass, glass block, and doors or skylights they are intended to protect.

1626.2.6.2 If external protection devices are not designed to be air tight, following the large missile impact test, they must resist an application of force corresponding to those listed in Table 1625.4 (fatigue load testing) without detaching from their mountings. The acting pressure cycles shall be simulated with loads applied through a mechanical system attached to the shutter specimen to apply uniformly around the shutter perimeter a force equal to the product of the required pressure and the area of the shutter specimen.

1626.2.7 If air leakage through the test specimen is excessive, tape may be used to cover any cracks and joints through which leakage is occurring. Tape shall not be used when there is a probability that it may significantly restrict differential movement between adjoining members. It is also permissible to cover both sides of the entire specimen and mounting panel with a single thickness of polyethylene film no thicker than 0.050 mm (2 mils). The technique of application is important in order that the full load is transferred to the specimen and that the membrane does not prevent movement or failure of the specimen. Apply the film loosely with extra folds of material at each corner and at all offsets and recesses. When the load is applied, there shall be no fillet caused by tightness of plastic film.

1626.2.8 A particular system of construction shall be deemed to comply with this recommended practice if three test specimens reject the two missile impacts without penetration and resist the cyclic pressure loading with no crack forming longer than 5 inches (127 mm) and $^{1}/_{16}$ inch (1.6 mm) wide through which air can pass.

1626.2.9 If only one of the three test specimens in a test fails to meet the above listed criteria, one retest of this system of construction (another test sequence with three specimens) shall be permitted.

1626.3 Small missile impact test.

1626.3.1 This test shall be conducted on three test specimens. This test shall be applicable to the construction units, assemblies, and materials to be used above 30 feet (9.1 m) in height in any and all structures.

1626.3.2 Each test specimen shall consist of the entire assembled unit, including frame and anchorage as supplied by the manufacturer for installation in the building, or as set forth in a referenced specification, if applicable. The fasteners used in mounting the test specimen shall be identical in size and spacing to those to be used in field installations.

1626.3.3 The missiles shall consist of solid steel balls each having a mass of 2 grams (0.07 oz) (+/-5 percent) with a $^{5}/_{16}$-in. (7.9 mm) nominal diameter.

1626.3.4 Each missile shall impact the surface of each test specimen at a speed of 130 feet per second (40 m/s).

1626.3.5 Each test specimen shall receive 30 small missile impacts except as noted in Sections 1626.3.5.1 and 1626.3.5.2 delivered in groups of 10 at a time: the first 10 distributed uniformly over a 2 square foot (0.19 m^2) area located at the center of the test specimen, the second 10 distributed uniformly over a 2 square foot area (0.19 m^2) located at the center of the long dimension of the specimen near the edge, and the third 10 distributed uniformly over a 2 square foot (0.19 m^2) area located at a corner of the specimen.

1626.3.5.1 For window and skylight assemblies, all impacts shall be to glass or other glazing infill. For test specimens with more than one light of glass, a single light closest to the center of the assembly shall be selected and impacted in accordance with Section 1626.3.5. If a light of glass is sufficiently small to cause the 5-inch (127 mm) radius circles to overlap, separate lights may be impacted; however, there must be a total of 30 impacts within the assembly.

1626.3.5.1.1 For window, fixed glass and skylight assemblies comprised of glass with different thickness, types of glass or different types of glazing infill, each separate thickness or type shall be impacted in accordance with Section 1626.3.5.

1626.3.5.2 For doors, wall cladding and external protection devices, all impacts shall be to the thinnest section through the assembly. For doors, wall cladding and external protection devices with horizontal and/or vertical bracing, all impacts shall be within a single area that is not reinforced and shall be impacted in accordance with Section 1626.3.5.

1626.3.5.2.1 For doors with glass, the glass shall be impacted in accordance with Section 1626.3.5 and the thinnest section through the assembly that is not glass shall be impacted in accordance with Section 1626.3.5.

1626.3.6 In the case of glazing, after completion of the small missile impacts, each test specimen shall then be subjected to the cyclic pressure loading defined in Table 1626.

1626.3.6.1 If external protection devices are employed to protect windows, doors or skylights, they must resist the small missile impacts specified in Sections 1626.3.3 and 1626.3.4 without deformations that result in contact with the windows, glass, doors or skylights they are intended to protect.

1626.3.6.2 If external protection devices are not designed to be air tight, following the small missile impact test, they must resist an application of force corresponding to those listed in Table 1625.4 (fatigue load testing) without detaching from their mountings. The acting pressure cycles shall be simulated with loads applied through a mechanical system attached to the shutter specimen to apply uniformly around the shutter perimeter a force equal to the product of the required pressure and the area of the shutter specimen.

1626.3.7 If air leakage through the test specimen is excessive, tape may be used to cover any cracks and joints through which leakage is occurring. Tape shall not be used when there is a probability that it may significantly restrict differential movement between adjoining members. It is also permissible to cover both sides of the entire specimen and mounting panel with a single thickness of polyethylene film no thicker than 0.050 mm (2 mils). The technique of application is important for the full load to be transferred to the specimen and to insure the membrane does not prevent movement or failure of the specimen. Apply the film loosely with extra folds of material at each corner and at all offsets and recesses. When the load is applied, there shall be no fillet caused by tightness of plastic film.

1626.3.8 A particular system of construction shall be deemed to comply with this test if three test specimens reject the small missile impacts without penetration and resist the cyclic pressure loading with no crack forming longer than 5

TABLE 1626
CYCLIC WIND PRESSURE LOADING

INWARD ACTING PRESSURE		OUTWARD ACTING PRESSURE	
RANGE	NUMBER OF CYCLES[1]	RANGE	NUMBER OF CYCLES[1]
0.2 P_{MAX} to 0.5 P_{MAX}[2]	3,500	0.3 P_{MAX} to 1.0 P_{MAX}	50
0.0 P_{MAX} to 0.6 P_{MAX}	300	0.5 P_{MAX} to 0.8 P_{MAX}	1,050
0.5 P_{MAX} to 0.8 P_{MAX}	600	0.0 P_{MAX} to 0.6 P_{MAX}	50
0.3 P_{MAX} to 1.0 P_{MAX}	100	0.2 P_{MAX} to 0.5 P_{MAX}	3,350

NOTES:
1. Each cycle shall have minimum duration of 1 second and a maximum duration of 3 seconds and must be performed in a continuous manner 1.
2. P_{MAX} denotes maximum design load in accordance with ASCE 7. The pressure spectrum shall be applied to each test specimen beginning with inward acting pressures followed by the outward acting pressures in the order from the top of each column to the bottom of each column.

inches (127 mm) and $^1/_{16}$ inch (1.6 mm) in width through which air can pass.

1626.3.9 If only one of the three test specimens in a test fails to meet the above listed criteria, one retest of the system (another test sequence with three specimens) of construction shall be permitted.

1626.4 Construction assemblies deemed to comply with Section 1626.

1. Exterior concrete masonry walls of minimum nominal 8-inch (203 mm) thickness, constructed in accordance with Chapter 21 (High-Velocity Hurricane Zones) of this code.
2. Exterior frame walls or gable ends constructed in accordance with Chapter 22 and Chapter 23 (High-Velocity Hurricane Zones) of this code, sheathed with a minimum $^{19}/_{32}$-inch (15 mm) CD exposure 1 plywood and clad with wire lath and stucco installed in accordance with Chapter 25 of this code.
3. Exterior frame walls and roofs constructed in accordance with Chapter 22 (High-Velocity Hurricane Zones) of this code sheathed with a minimum 24-gage rib deck type material and clad with an approved wall finish.
4. Exterior reinforced concrete elements constructed of solid normal weight concrete (no voids), designed in accordance with Chapter 19 (High-Velocity Hurricane Zones) of this code and having a minimum 2-in. (51 mm) thickness.
5. Roof systems constructed in accordance with Chapter 22 or Chapter 23 (High-Velocity Hurricane Zones) of this code, sheathed with a minimum $^{19}/_{32}$-inch (15 mm) CD exposure 1 plywood or minimum nominal 1-inch (25 mm) wood decking and surfaced with an approved roof system installed in accordance with Chapter 15 of this code.

All connectors shall be specified by the building designer of record for all loads except impact.

CHAPTER 17

STRUCTURAL TESTS AND SPECIAL INSPECTIONS

SECTION 1701 GENERAL

1701.1 Scope. The provisions of this chapter shall govern the quality, workmanship and requirements for materials covered. Materials of construction and tests shall conform to the applicable standards listed in this code.

1701.2 New materials. New building materials, equipment, appliances, systems or methods of construction not provided for in this code, and any material of questioned suitability proposed for use in the construction of a building or structure, shall be subjected to the tests prescribed in this chapter and in the approved rules to determine character, quality and limitations of use.

1701.3 Used materials. The use of second-hand materials that meet the minimum requirements of this code for new materials shall be permitted.

SECTION 1702 DEFINITIONS

1702.1 General. The following words and terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meanings shown herein.

APPROVED AGENCY. An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved.

APPROVED FABRICATOR. An established and qualified person, firm or corporation approved by the building official pursuant to Chapter 17 of this code.

CERTIFICATE OF COMPLIANCE. A certificate stating that materials and products meet specified standards or that work was done in compliance with approved construction documents.

DESIGNATED SEISMIC SYSTEM. Reserved.

FABRICATED ITEM. Structural, load-bearing or lateral load-resisting assemblies consisting of materials assembled prior to installation in a building or structure or subjected to operations such as heat treatment, thermal cutting, cold working or reforming after manufacture and prior to installation in a building or structure. Materials produced in accordance with standard specifications referenced by this code, such as rolled structural steel shapes, steel-reinforcing bars, masonry units and wood structural panels shall not be considered "fabricated items."

GARAGE DOOR MANUFACTURER. The party responsible for the completed assembly of the garage door components.

INSPECTION CERTIFICATE. An identification applied on a product by an approved agency containing the name of the manufacturer, the function and performance characteristics, and the name and identification of an approved agency that indicates that the product or material has been inspected and evaluated by an approved agency (see Section 1703.5 and "Label," "Manufacturer's designation" and "Mark").

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 (see Section 1703.5 and "Inspection certificate," "Manufacturer's designation" and "Mark").

MAIN WIND-FORCE-RESISTING SYSTEM. An assemblage of structural elements assigned to provide support and stability for the overall structure. The system generally receives wind loading from more than one surface.

MANUFACTURER'S DESIGNATION. An identification applied on a product by the manufacturer indicating that a product or material complies with a specified standard or set of rules (see also "Inspection certificate," "Label" and "Mark").

MARK. An identification applied on a product by the manufacturer indicating the name of the manufacturer and the function of a product or material (see also "Inspection certificate," "Label" and "Manufacturer's designation").

PERMANENT LABEL. A label that cannot be removed without noticeable damange.

SPECIAL INSPECTION. Reserved.

SPECIAL INSPECTION, CONTINUOUS. Reserved.

SPECIAL INSPECTION, PERIODIC. Reserved.

SPRAYED FIRE-RESISTANT MATERIALS. Cementitious or fibrous materials that are spray applied to provide fire-resistant protection of the substrates.

STRUCTURAL OBSERVATION. Reserved.

SECTION 1703 APPROVALS

1703.1 Approved agency. An approved agency shall provide all information as necessary for the building official to determine that the agency meets the applicable requirements.

1703.1.1 Independent. An approved agency shall be objective and competent. The agency shall also disclose possible conflicts of interest so that objectivity can be confirmed.

1703.1.2 Equipment. An approved agency shall have adequate equipment to perform required tests. The equipment shall be periodically calibrated.

1703.1.3 Personnel. An approved agency shall employ experienced personnel educated in conducting, supervising and evaluating tests and/or inspections.

1703.2 Written approval. Any material, appliance, equipment, system or method of construction meeting the requirements of this code shall be approved in writing after satisfactory completion of the required tests and submission of required test reports.

1703.3 Approved record. For any material, appliance, equipment, system or method of construction that has been approved, a record of such approval, including the conditions and limitations of the approval, shall be kept on file in the building official's office and shall be open to public inspection at appropriate times.

1703.4 Performance. Specific information consisting of test reports conducted by an approved testing agency in accordance with standards referenced in Chapter 35, or other such information as necessary, shall be provided for the building official to determine that the material meets the applicable code requirements.

1703.4.1 Research and investigation. Sufficient technical data shall be submitted to the building official to substantiate the proposed use of any material or assembly. If it is determined that the evidence submitted is satisfactory proof of performance for the use intended, the building official shall approve the use of the material or assembly subject to the requirements of this code. The costs, reports and investigations required under these provisions shall be paid by the permit applicant.

1703.4.2 Research reports. Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from approved sources.

1703.5 Labeling. Where materials or assemblies are required by this code to be labeled, such materials and assemblies shall be labeled by an approved agency in accordance with Section 1703. Products and materials required to be labeled shall be labeled in accordance with the procedures set forth in Sections 1703.5.1 through 1703.5.3.

1703.5.1 Testing. An approved agency shall test a representative sample of the product or material being labeled to the relevant standard or standards. The approved agency shall maintain a record of the tests performed. The record shall provide sufficient detail to verify compliance with the test standard.

1703.5.2 Inspection and identification. The approved agency shall periodically perform an inspection, which shall be in-plant if necessary, of the product or material that is to be labeled. The inspection shall verify that the labeled product or material is representative of the product or material tested.

1703.5.3 Label information. The label shall contain the manufacturer's or distributor's identification, model number, serial number or definitive information describing the product or material's performance characteristics and approved agency's identification.

1703.6 Heretofore approved materials. The use of any material already fabricated or of any construction already erected, which conformed to requirements or approvals heretofore in effect, shall be permitted to continue, if not detrimental to life, health or safety to the public.

1703.7 Evaluation and follow-up inspection services. Where structural components or other items regulated by this code are not visible for inspection after completion of a prefabricated assembly, the permit applicant shall submit a report of each prefabricated assembly. The report shall indicate the complete details of the assembly, including a description of the assembly and its components, the basis upon which the assembly is being evaluated, test results and similar information and other data as necessary for the building official to determine conformance to this code. Such a report shall be approved by the building official.

1703.7.1 Follow-up inspection. Reserved.

1703.7.2 Test and inspection records. Copies of necessary test and inspection records shall be filed with the building official.

SECTION 1704
SPECIAL INSPECTIONS
RESERVED

SECTION 1705
QUALITY ASSURANCE FOR SEISMIC RESISTANCE
RESERVED

SECTION 1706
QUALITY ASSURANCE FOR WIND RESISTANCE
RESERVED

SECTION 1707
SPECIAL INSPECTIONS FOR SEISMIC RESISTANCE
RESERVED

SECTION 1708
STRUCTURAL TESTING FOR SEISMIC RESISTANCE
RESERVED

SECTION 1709
STRUCTURAL OBSERVATIONS
RESERVED

SECTION 1710
DESIGN STRENGTHS OF MATERIALS

1710.1 Conformance to standards. The design strengths and permissible stresses of any structural material that are identified by a manufacturer's designation as to manufacture and grade by mill tests, or the strength and stress grade is otherwise confirmed to the satisfaction of the building official, shall conform to the specifications and methods of design of accepted engineering practice or the approved rules in the absence of applicable standards.

1710.2 New materials. For materials that are not specifically provided for in this code, the design strengths and permissible stresses shall be established by tests as provided for in Section 1711.

SECTION 1711
ALTERNATIVE TEST PROCEDURE

1711.1 General. In the absence of approved rules or other approved standards, the building official shall make, or cause to be made, the necessary tests and investigations; or the building official shall accept duly authenticated reports from approved agencies in respect to the quality and manner of use of new materials or assemblies as provided for in Section 104.11. The cost of all tests and other investigations required under the provisions of this code shall be borne by the permit applicant.

SECTION 1712
TEST SAFE LOAD

1712.1 Where required. Where proposed construction is not capable of being designed by approved engineering analysis, or where proposed construction design method does not comply with the applicable material design standard, the system of construction or the structural unit and the connections shall be subjected to the tests prescribed in Section 1714. The building official shall accept certified reports of such tests conducted by an approved testing agency, provided that such tests meet the requirements of this code and approved procedures.

SECTION 1713
IN-SITU LOAD TESTS

1713.1 General. Whenever there is a reasonable doubt as to the stability or load-bearing capacity of a completed building, structure or portion thereof for the expected loads, an engineering assessment shall be required. The engineering assessment shall involve either a structural analysis or an in-situ load test, or both. The structural analysis shall be based on actual material properties and other as-built conditions that affect stability or load-bearing capacity, and shall be conducted in accordance with the applicable design standard. If the structural assessment determines that the load-bearing capacity is less than that required by the code, load tests shall be conducted in accordance with Section 1713.2. If the building, structure or portion thereof is found to have inadequate stability or load-bearing capacity for the expected loads, modifications to ensure structural adequacy or the removal of the inadequate construction shall be required.

1713.2 Test standards. Structural components and assemblies shall be tested in accordance with the appropriate material standards listed in Chapter 35. In the absence of a standard that contains an applicable load test procedure, the test procedure shall be developed by a registered design professional and approved. The test procedure shall simulate loads and conditions of application that the completed structure or portion thereof will be subjected to in normal use.

1713.3 In-situ load tests. In-situ load tests shall be conducted in accordance with Section 1713.3.1 or 1713.3.2 and shall be supervised by a registered design professional. The test shall simulate the applicable loading conditions specified in Chapter 16 as necessary to address the concerns regarding structural stability of the building, structure or portion thereof.

1713.3.1 Load test procedure specified. Where a standard listed in Chapter 35 contains an applicable load test procedure and acceptance criteria, the test procedure and acceptance criteria in the standard shall apply. In the absence of specific load factors or acceptance criteria, the load factors and acceptance criteria in Section 1713.3.2 shall apply.

1713.3.2 Load test procedure not specified. In the absence of applicable load test procedures contained within a standard referenced by this code or acceptance criteria for a specific material or method of construction, such existing structure shall be subjected to a test procedure developed by a registered design professional that simulates applicable loading and deformation conditions. For components that are not a part of the seismic-load-resisting system, the test load shall be equal to two times the unfactored design loads. The test load shall be left in place for a period of 24 hours. The structure shall be considered to have successfully met the test requirements where the following criteria are satisfied:

1. Under the design load, the deflection shall not exceed the limitations specified in Section 1604.3. The HVHZ shall comply with Section 1613.1.
2. Within 24 hours after removal of the test load, the structure shall have recovered not less than 75 percent of the maximum deflection.
3. During and immediately after the test, the structure shall not show evidence of failure.

SECTION 1714
PRECONSTRUCTION LOAD TESTS

1714.1 General. In evaluating the physical properties of materials and methods of construction that are not capable of being designed by approved engineering analysis or do not comply with applicable material design standards listed in Chapter 35, the structural adequacy shall be predetermined based on the load test criteria established in this section.

1714.2 Load test procedures specified. Where specific load test procedures, load factors and acceptance criteria are included in the applicable design standards listed in Chapter 35, such test procedures, load factors and acceptance criteria shall apply. In the absence of specific test procedures, load factors or acceptance criteria, the corresponding provisions in Section 1714.3 shall apply.

1714.3 Load test procedures not specified. Where load test procedures are not specified in the applicable design standards listed in Chapter 35, the load-bearing and deformation capacity of structural components and assemblies shall be determined on the basis of a test procedure developed by a registered design professional that simulates applicable loading and deformation conditions. For components and assemblies that are not a part of the seismic-load-resisting system, the test shall be as specified in Section 1714.3.1. Load tests shall simulate the applicable loading conditions specified in Chapter 16.

1714.3.1 Test procedure. The test assembly shall be subjected to an increasing superimposed load equal to not less than two times the superimposed design load. The test load shall be left in place for a period of 24 hours. The tested assembly shall be considered to have successfully met the test requirements if the assembly recovers not less than 75 percent of the maximum deflection within 24 hours after the removal of the test load. The test assembly shall then be reloaded and subjected to an increasing superimposed load until either structural failure occurs or the superimposed load is equal to two and one-half times the load at which the deflection limitations specified in Section 1714.3.2 were reached, or the load is equal to two and one-half times the superimposed design load. In the case of structural components and assemblies for which deflection limitations are not specified in Section 1714.3.2, the test specimen shall be subjected to an increasing superimposed load until structural failure occurs or the load is equal to two and one-half times the desired superimposed design load. The allowable superimposed design load shall be taken as the lesser of:

1. The load at the deflection limitation given in Section 1714.3.2.
2. The failure load divided by 2.5.
3. The maximum load applied divided by 2.5.

1714.3.2 Deflection. The deflection of structural members under the design load shall not exceed the limitations in Section 1604.3. The HVHZ shall comply with Section 1613.1.

1714.4 Wall and partition assemblies. Load-bearing wall and partition assemblies shall sustain the test load both with and without window framing. The test load shall include all design load components. Wall and partition assemblies shall be tested both with and without door and window framing.

1714.5 Exterior window and door assemblies. This section defines performance and construction requirements for exterior window and door assemblies installed in wall systems. Waterproofing, sealing and flashing systems are not included in the scope of this section.

1714.5.1 The design pressure for window and door assemblies shall be calculated in accordance with component and cladding wind loads in Section 1609.

1714.5.2 Exterior windows, sliding and patio glass doors.

1714.5.2.1 Testing and labeling. Exterior windows and glass doors shall be tested by an approved independent testing laboratory, and shall be labeled with an approved label identifying the manufacturer, performance characteristics and approved product certification agency, testing laboratory, evaluation entity or Miami-Dade Product Approval to indicate compliance with the requirements of one of the following specifications:

ANSI/AAMA/NWWDA 101/I.S. 2 or 101/I.S. 2/NAFS or AAMA/WDMA/CSA 101/I.S. 2/A440 or TAS 202 (HVHZ shall comply with TAS 202 utilizing ASTM E 1300-98 or ASTM E 1300-02 or Section 2404).

Exceptions:

1. Door assemblies installed in nonhabitable areas where the door assembly and area are designed to accept water infiltration need not be tested for water infiltration.
2. Door assemblies installed where the overhang (OH) ratio is equal to or more than 1 need not be tested for water infiltration. The overhang ratio shall be calculated by the following equation:

   OH ratio = OH Length/OH Height

   Where:

   OH length = The horizontal measure of how far an overhang over a door projects out from door surface.

   OH height = The vertical measure of the distance from the door sill to the bottom of the overhang over a door.
3. Pass-through windows for serving from a single-family kitchen, where protected by a roof overhang of 5 feet (1.5 m) or more shall be exempted from the requirements of the water infiltration test.

The permanent label is limited to only one design pressure rating per reference standard per label.

Exterior windows and glass doors shall be labeled with a temporary supplemental label printed and applied by the manufacturer. The label shall identify the manufacturer, products model/series number, positive and negative design pressure rating, products maximum size, glazing thickness, indicate impact rated if applicable, Florida Product Approval or Miami-Dade Product Approval number if applicable, and applicable test standard. The supplemental label is limited to only one design pressure rating per reference standard per label. This supplemental label shall remain on the window until final approval by the building official.

The permanent label shall always be the default label in case the temporary label is missing or no longer legible for final approval by the building official.

Glass Strength: Products tested and labeled as conforming to ANSI/AAMA/NWWDA 101/I.S. 2 or 101/I.S. 2/NAFS or AAMA/WDMA/CSA 101/I.S. 2/A440 or TAS 202 shall not be subject to the requirements of Sections 2403.2 or 2403.3 or 2404.1. Determination of load resistance of glass for specific loads of products not tested and certified in accordance with Section 1714.5.2.1 shall be designed and labeled to comply with ASTM E 1300 in accordance with Section 2404. The supplemental label shall designate the type and thickness of glass or glazing material.

1714.5.2.1.1 Testing and labeling of skylights. Exterior skylights shall be tested by an approved independent testing laboratory, and shall be labeled with an approved permanent label identifying the manufacturer, the products model/series number, performance characteristics and approved product evaluation entity to indicate compliance with the requirements of the following specification:

AAMA/WDMA 101/I.S.2/NAFS, Voluntary Performance Specification for Windows, Skylights and Glass Doors, or TAS 202 (HVHZ shall comply with TAS 202).

The permanent label is limited to only one design pressure rating per reference standard per label.

Exterior skylights shall be labeled with a temporary supplemental label printed and applied by the manufacturer. The label shall identify the manufacturer, products model/series number, positive and negative design pressure rating, products maximum size, glazing thickness, indicate impact rated if applicable, Florida Product Approval or Miami-Dade Product Approval number if applicable, and applicable test standard. The supplemental label is limited to only one design pressure rating per reference standard per label. This supplemental label shall remain on the window until final approval by the building official. The permanent label shall always be the default label in case the temporary label is missing or no longer legible for final approval by the building official.

1714.5.2.2 Supplemental label. A temporary supplemental label conforming to AAMA 203, Procedural Guide for the Window Inspection and Notification System, shall be acceptable for establishing calculated allowable design pressures higher than indicated on the label required by Section 1714.5.2.1 for window sizes smaller than that required by the ANSI/AAMA/NWWDA 101/I.S.2 or 101/I.S. 2/NAFS or AAMA/WDMA/CSA 101/I.S.2/A440 test requirements. This supplemental label shall remain on the window until final approval by the building official.

Exception 1:

Comparative analysis of operative windows and glazed doors may be made, provided the proposed unit complies with the following:

1. Shall always be compared with a tested and currently approved unit.
2. Varies only in width, height and/or load requirements.
3. Shall not exceed 100 percent of the proportional deflection for fiber stress of the intermediate members of the approved unit.
4. Shall conform as to extruded members, reinforcement and in all other ways with the tested approved unit.
5. Shall not exceed 100 percent of the concentrated load at the juncture of the intermediate members and the frame of the approved unit.
6. Shall not permit more air and water infiltration than the approved unit based on the height above grade.
7. Compared unit shall not exceed the maximum cyclic pressure when tested per TAS 203 or ASTM E 1886 and ASTM E 1996.

Exception 2 :

Comparative analysis of fixed glass windows may be made provided the proposed unit complies with the following:

1. Shall always be compared with a tested and currently approved unit.
2. Varies only in width, height and/or load requirements.
3. The design is identical in all respects. e.g., extrusions, glazing system, joinery, fasteners, etc.
4. Shall not permit more air and water infiltration than the approved unit based on height above grade.
5. The maximum uniform load distribution (ULD) of any side is equal to the uniform load carried by the side divided by the length of the side.
6. The ULD of any member must not exceed the ULD of the corresponding member of the tested window.
7. The uniform load distribution on each member shall be calculated in accordance to Section 2, Engineering Design Rules, of the AAMA 103.3 Procedural Guide.
8. Compared unit shall not exceed the maximum cyclic pressure when tested per TAS 201,TAS 202 and TAS 203 or ASTM E 1886 and ASTM E 1996.

1714.5.3 Exterior door assemblies. Exterior door assemblies not covered by Section 1714.4.2 or Section 1714.5.3.1 shall be tested for structural integrity in accordance with ASTM E 330 Procedure A, at a load of 1.5 times the required design pressure load. The load shall be sustained for 10 seconds with no permanent deformation of any main frame or panel member in excess of 0.4 percent of its span after the load is removed. High-velocity hurricane zones shall comply with TAS 202. After each specified loading, there shall be no glass breakage, permanent damage to fasteners, hardware parts, or any other damage which causes the door to be inoperable.

The minimum test sizes and minimum design pressures shall be as indicated in Table 1714.5.3.

The unit size tested shall qualify all units smaller in width and/or height of the same operation type and be limited to cases where frame, panels and structural members maintain the same profile as tested.

TABLE 1714.5.3
MINIMUM TEST SIZES, INCLUDING FRAMING

PERFORMANCE CLASS[1]	WIDTH X HEIGHT (mm)	WIDTH X HEIGHT (IN.)	MINIMUM PERFORMANCE GRADE (DESIGN PRESSURE)
Residential (R)	900 × 2000	(36 × 79)	720 Pa (15 psf)
Light Commercial (LC)	900 × 2100	(36 × 83)	1200 Pa (25 psf)
Commercial (C)	1000 × 2100	(40 × 83)	1440 Pa (25 psf)
Heavy Commercial (HC)	1200 × 2400	(48 × 95)	1920 Pa (40 psf)
Architectural (AW)	1200 × 2400	(48 × 95)	1920 Pa (40 psf)

1. Performance Class and Performance Grade per ANSI/AAMA/NWWDA 101/I.S.2.

1714.5.3.1 Sectional garage doors and rolling doors shall be tested for determination of structural performance under uniform static air pressure difference in accordance with ANSI/DASMA 108, ASTM E 330 Procedure A, or TAS 202. For products tested in accordance with ASTM E 330, testing shall include a load of 1.5 times the required design pressure load sustained for 10 seconds, and acceptance criteria shall be in accordance with ANSI/DASMA 108 (HVHZ shall comply with TAS 202).

1714.5.3.2 Custom doors. Custom (one of a kind) exterior door assemblies shall be tested by an approved testing laboratory or be engineered in accordance with accepted engineering practices.

1714.5.3.3 Door components evaluated by an approved product evaluation entity, certification agency, testing laboratory or engineer may be interchangeable in exterior door assemblies provided that the door component(s) provide equal or greater structural performance as demonstrated by accepted engineering practices.

1714.5.3.3.1 Glazed curtain wall, window wall and storefront systems shall be tested in accordance with the requirements of this section and the Laboratory Test requirements of the American Architectural Manufacturers Association (AAMA) Standard 501; HVHZ shall comply with Section 2411.3.2.1.1.

Exceptions:

1. Door assemblies installed in nonhabitable areas where the door assembly and area are designed to accept water infiltration need not be tested for water infiltration.
2. Door assemblies installed where the overhang (OH) ratio is equal to or more than 1 need not be tested for water infiltration. The overhang ratio shall be calculated by the following equation:

   OH ratio = OH Length/OH Height

   where:

   OH Length = The horizontal measure of how far an overhang over a door projects out from door surface.

   OH Height = The vertical measure of the distance from the door sill to the bottom of the overhang over a door.

1714.5.3.3.2 Optional exterior door component testing. With the exception of HVHZ, exterior side-hinged door assemblies not covered by Section 1714.5.2 shall have the option to have the components of the assembly tested and rated for structural integrity in accordance with the following specification:

SDI A250.13

Following the structural testing of exterior door components, there shall be no permanent deformation of any perimeter frame or panel member in excess of 0.4 percent of its span after the load is removed. After each specified loading, there shall be no glass breakage, permanent damage to fasteners, hardware parts, or any other damage that causes the door to be inoperable, as applicable.

1714.5.3.4 Garage door labeling. Garage doors shall be labeled with a permanent label provided by the manufacturer. The label shall identify the manufacturer, the garage door model/series number, the positive and negative design pressure rating, indicate impact rated if applicable, the installation instruction drawing reference number, the Florida Product Approval or Miami-Dade Product Approval number if applicable, and the applicable test standards.

The required garage door components for an approved garage door assembly may be indicated using a checklist format on the label. If a checklist format is used on the label, the installer or manufacturer shall mark the selected components on the checklist that are required to assemble an approved garage door system.

The installation instructions shall be provided and available on the job site.

1714.5.4 Anchorage methods. The methods cited in this section apply only to anchorage of window and door assemblies to the main wind force resisting system.

1714.5.4.1 Anchoring requirements. Window and door assemblies shall be anchored in accordance with the published manufacturer's recommendations to achieve the design pressure specified. Substitute anchoring systems used for substrates not specified by the fenestration manufacturer shall provide equal or greater anchoring performance as demonstrated by accepted engineering practice.

1714.5.4.2 Masonry, concrete or other structural substrate. Where the wood shim or buck thickness is less than $1^1/_2$ inches (38 mm), window and door assemblies shall be anchored through the main frame or by jamb clip or subframe system, in accordance with the manufacturer's published installation instructions. Anchors shall be securely fastened directly into the masonry, concrete or other structural substrate material. Unless otherwise tested, bucks shall extend beyond the interior face of the window or door frame such that full support of the frame is provided. Shims shall be made from materials capable of sustaining applicable loads, located and applied in a thickness capable of sustaining applicable loads. Anchors shall be provided to transfer load from the window or door frame to the rough opening substrate.

Where the wood buck thickness is $1^1/_4$ inches (38 mm) or greater, the buck shall be securely fastened to transfer load to the masonry, concrete or other structural subtrate and the buck shall extend beyond the interior face of the window or door frame. Window and door assemblies shall be anchored through the main frame or by jamb clip or subframe system or through the flange to the secured wood buck in accordance with the manufacturer's published installation instructions. Unless otherwise tested, bucks shall extend beyond the interior face of the window or door frame such that full support of the frame is provided. Shims shall be made from materials capable of sustaining applicable loads, located and applied in a thickness capable of sustaining applicable loads. Anchors shall be provided to transfer load from the window or door frame assembly to the secured wood buck.

1714.5.4.3 Wood or other approved framing materials. Where the framing material is wood or other approved framing material, window and glass door assemblies shall be anchored through the main frame or by jamb clip or subframe system or through the flange in accordance with the manufacturer's published installation instructions. Shims shall be made from materials capable of sustaining applicable loads, located and applied in a thickness capable of sustaining applicable loads. Anchors shall be provided to transfer load from the window or door frame to the rough opening substrate.

1714.5.5 Mullions occurring between individual window and glass door assemblies.

1714.5.5.1 Mullions. Mullions or mulled fenestration assemblies shall be tested by an approved testing laboratory in accordance with either AAMA 450, ASTM E 330, or TAS 202 (HVHZ shall comply with TAS 202), or shall be engineered in accordance with AAMA 450 using accepted engineering practice. Mullions tested as stand-alone units or qualified by engineering shall use performance criteria cited in Sections 1714.5.5.2, 1714.5.5.3 and 1714.5.5.4. Mullions qualified by an actual test of an entire assembly shall comply with Section 1714.5.5.4, except that mullions in assemblies requiring a deflection limitation, as defined in AAMA/WDMA/CSA 101/I.S.2/A440, shall meet Sections 1714.5.5.2 and 1714.5.5.3. Products not included within the scope of Section 1714.5.5.1 shall comply with Sections 1714.5.5.3 and 1714.5.5.4.

1714.5.5.2 Load transfer. Mullions shall be designed to transfer the design pressure loads applied by the window and door assemblies to the rough opening substrate.

1714.5.5.3 Deflection. Mullions shall be capable of resisting the design pressure loads applied by the window and door assemblies to be supported without deflecting more than L/175, where L is the span of the mullion in inches.

1714.5.5.4 Structural safety factor. Mullions that are tested by an approved testing laboratory shall be capable of resisting a load of 1.5 times the design pressure loads applied by the window and door assemblies to be supported. The 1.5 times the design pressure load shall be sustained for 10 seconds, and the permanent deformation shall not exceed 0.2 percent of the mullion span for assemblies requiring deflection limitations, as defined in AAMA/WDMA/CSA 101/I.S.2/A440 and 0.4 percent of the mullion span for all other assemblies after the 1.5 times design pressure load is removed. Mullions that are qualified by engineering shall be capable of resisting the design pressure loads applied by the window and door assemblies to be supported without exceeding the allowable stress of the mullion elements.

1714.6 Test specimens. Test specimens and construction shall be representative of the materials, workmanship and details normally used in practice. The properties of the materials used to construct the test assembly shall be determined on the basis of tests on samples taken from the load assembly or on representative samples (when TAS 202 is used, a minimum of three specimens) of the materials used to construct the load test assembly. Required tests shall be conducted or witnessed by an approved agency.

1714.7 Installation instruction for exterior windows and doors. Windows and doors shall be installed in accordance with the manufacturer's installation instruction.

1714.8 Impact-resistant coverings.

1714.8.1 Labels. A permanent label shall be provided by the product approval holder on all impact-resistant coverings.

1714.8.2 The following information shall be included on the labels on impact-resistant coverings:

1. Product approval holder name and address.
2. All applicable methods of approval. Methods of approval include, but are not limited to Miami-Dade NOA; Florida Building Commission, TDI Product Evaluation; ICC-ES.
3. The test standard or standards specified at Section 1609.1.2, including standards referenced within the test standards specified at Section 1609.1.2 used to demonstrate code compliance.
4. For products with a Florida Product Approval Number or a Miami-Dade County Building Code Compliance Office Notice of Acceptance Number (NOA), such numbers shall be included on the label.

1714.8.3 Location of label. The location of the label on the impact-resistant covering shall be as follows:

1. Accordions: Bottom of the locking bar or center mate facing the exterior or outside.
2. Rollup: On the bottom of the hood facing the exterior or outside or on the bottom slat facing the exterior or outside.
3. Bahama Awning or Colonial Hinged: On the bottom, placed on the back of the shutter.
4. Panels: For metal and plastic panels the label may be embossed or printed spaced not more than every three (3) lineal feet on each panel. The label shall be applied by the holder of the product approval and shall face the exterior or outside.
5. Framed products: The label shall be on the side or bottom facing the exterior or outside.
6. Labels on all other products shall face the exterior or outside.

1714.8.4 Installation. All impact-resistant coverings shall be installed in accordance with the manufacturer's installation instructions and in accordance with the product approval. Installation instructions shall be provided and shall be available to inspection personnel on the job site. Opening protection components, fasteners, and other parts evaluated by an approved product evaluation entity, certification agency, testing laboratory, architect, or engineer and approved by the holder of the product approval may be interchangeable in opening protection assemblies provided that the opening protection component(s) provide equal or greater structural performance and durability as demonstrated by testing in accordance with approved test standards.

SECTION 1715
MATERIAL AND TEST STANDARDS

1715.1 Test standards for joist hangers and connectors.

1715.1.1 Test standards for joist hangers. The vertical load-bearing capacity, torsional moment capacity and deflection characteristics of joist hangers shall be determined in accordance with ASTM D 1761 using lumber having a specific gravity of 0.49 or greater, but not greater than 0.55, as determined in accordance with AF&PA NDS for the joist and headers.

Exception: The joist length shall not be required to exceed 24 inches (610 mm).

1715.1.2 Vertical load capacity for joist hangers. The vertical load capacity for the joist hanger shall be determined by testing a minimum of three joist hanger assemblies as specified in ASTM D 1761. If the ultimate vertical load for any one of the tests varies more than 20 percent from the average ultimate vertical load, at least three additional tests shall be conducted. The allowable vertical load of the joist hanger shall be the lowest value determined from the following:

1. The lowest ultimate vertical load for a single hanger from any test divided by three (where three tests are conducted and each ultimate vertical load does not vary more than 20 percent from the average ultimate vertical load).
2. The average ultimate vertical load for a single hanger from all tests divided by three (where six or more tests are conducted).
3. The average from all tests of the vertical loads that produce a vertical movement of the joist with respect to the header of 0.125 inch (3.2 mm).
4. The sum of the allowable design loads for nails or other fasteners utilized to secure the joist hanger to the wood members and allowable bearing loads that contribute to the capacity of the hanger.
5. The allowable design load for the wood members forming the connection.

1715.1.3 Torsional moment capacity for joist hangers. The torsional moment capacity for the joist hanger shall be determined by testing at least three joist hanger assemblies as specified in ASTM D 1761. The allowable torsional moment of the joist hanger shall be the average torsional moment at which the lateral movement of the top or bottom of the joist with respect to the original position of the joist is 0.125 inch (3.2 mm).

1715.1.4 Design value modifications for joist hangers. Allowable design values for joist hangers that are determined by Item 4 or 5 in Section 1715.1.2 shall be permitted to be modified by the appropriate duration of loading factors as specified in AF&PA NDS but shall not exceed the direct loads as determined by Item 1, 2 or 3 in Section 1715.1.2. Allowable design values determined by Item 1, 2 or 3 in Section 1715.1.2 and 2305.1 shall not be modified by duration of loading factors.

1715.2 Concrete and clay roof tiles.

1715.2.1 Overturning resistance. Concrete and clay roof tiles shall be tested to determine their resistance to overturning due to wind in accordance with SBCCI SSTD 11 or TAS 108 (high-velocity hurricane zones shall comply with TAS 108) and Chapter 15.

1715.2.2 Wind tunnel testing. When roof tiles do not satisfy the limitations in Chapter 16 for rigid tile, a wind tunnel test shall be used to determine the wind characteristics of the concrete or clay tile roof covering in accordance with SBCCI SSTD 11 or TAS 108 (high-velocity hurricane zones shall comply with TAS 108) and Chapter 15.

CHAPTER 18
SOILS AND FOUNDATIONS

SECTION 1801
GENERAL

1801.1 Scope. The provisions of this chapter shall apply to building and foundation systems in those areas not subject to scour or water pressure by wind and wave action. Buildings and foundations subject to such scour or water pressure loads shall be designed in accordance with Chapter 16.

> **Exception:** Buildings and structures located within the high-velocity hurricane zone shall comply with the provisions of Sections 1816 through 1834.

1801.2 Design. Allowable bearing pressures, allowable stresses and design formulas provided in this chapter shall be used with the allowable stress design load combinations specified in Section 1605.3. The quality and design of materials used structurally in excavations, footings and foundations shall conform to the requirements specified in Chapters 16, 19, 21, 22 and 23 of this code. Excavations and fills shall also comply with Chapter 33.

1801.2.1 Foundation design for seismic overturning. Reserved.

SECTION 1802
FOUNDATION AND SOILS INVESTIGATIONS

1802.1 General. Foundation and soils investigations shall be conducted in conformance with Sections 1802.2 through 1802.6. Where required by the building official, the classification and investigation of the soil shall be made by a registered design professional.

1802.2 Where required. The owner or applicant shall submit a foundation and soils investigation to the building official where required in Sections 1802.2.1 through 1802.2.7.

> **Exception:** The building official need not require a foundation or soils investigation where satisfactory data from adjacent areas is available that demonstrates an investigation is not necessary for any of the conditions in Sections 1802.2.1 through 1802.2.6.

1802.2.1 Questionable soil. Where the classification, strength or compressibility of the soil are in doubt or where a load-bearing value superior to that specified in this code is claimed, the building official shall require that the necessary investigation be made. Such investigation shall comply with the provisions of Sections 1802.4 through 1802.6.

1802.2.2 Expansive soils. In areas likely to have expansive soil, the building official shall require soil tests to determine where such soils do exist.

1802.2.3 Ground-water table. A subsurface soil investigation shall be performed to determine whether the existing ground-water table is above or within 5 feet (1524 mm) below the elevation of the lowest floor level where such floor is located below the finished ground level adjacent to the foundation.

> **Exception:** A subsurface soil investigation shall not be required where waterproofing is provided in accordance with Section 1807.

1802.2.4 Pile and pier foundations. Pile and pier foundations shall be designed and installed on the basis of a foundation investigation and report as specified in Sections 1802.4 through 1802.6 and Section 1808.2.2.

1802.2.5 Rock strata. Where subsurface explorations at the project site indicate variations or doubtful characteristics in the structure of the rock upon which foundations are to be constructed, a sufficient number of borings shall be made to a depth of not less than 10 feet (3048 mm) below the level of the foundations to provide assurance of the soundness of the foundation bed and its load-bearing capacity.

1802.2.6 Seismic Design Category C. Reserved.

1802.2.7 Seismic Design Category D, E or F. Reserved.

1802.3 Soil classification. Where required, soils shall be classified in accordance with Section 1802.3.1 or 1802.3.2.

1802.3.1 General. For the purposes of this chapter, the definition and classification of soil materials for use in Table 1804.2 shall be in accordance with ASTM D 2487.

1802.3.2 Expansive soils. Soils meeting all four of the following provisions shall be considered expansive, except that tests to show compliance with Items 1, 2 and 3 shall not be required if the test prescribed in Item 4 is conducted:

1. Plasticity index (PI) of 15 or greater, determined in accordance with ASTM D 4318.
2. More than 10 percent of the soil particles pass a No. 200 sieve (75 μm), determined in accordance with ASTM D 422.
3. More than 10 percent of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D 422.
4. Expansion index greater than 20, determined in accordance with ASTM D 4829.

1802.4 Investigation. Soil classification shall be based on observation and any necessary tests of the materials disclosed by borings, test pits or other subsurface exploration made in appropriate locations. Additional studies shall be made as necessary to evaluate slope stability, soil strength, position and adequacy of load-bearing soils, the effect of moisture variation on soil-bearing capacity, compressibility, liquefaction and expansiveness.

1802.4.1 Exploratory boring. The scope of the soil investigation including the number and types of borings or soundings, the equipment used to drill and sample, the in-situ testing equipment and the laboratory testing program shall be determined by a registered design professional.

1802.5 Soil boring and sampling. The soil boring and sampling procedure and apparatus shall be in accordance with generally accepted engineering practice. The registered design professional shall have a fully qualified representative on the site during all boring and sampling operations.

1802.6 Reports. The soil classification and design load-bearing capacity shall be shown on the construction documents. Where required by the building official, a written report of the investigation shall be submitted that includes, but need not be limited to, the following information:

1. A plot showing the location of test borings and/or excavations.
2. A complete record of the soil samples.
3. A record of the soil profile.
4. Elevation of the water table, if encountered.
5. Recommendations for foundation type and design criteria, including but not limited to: bearing capacity of natural or compacted soil; provisions to mitigate the effects of expansive soils; mitigation of the effects of liquefaction, differential settlement and varying soil strength; and the effects of adjacent loads.
6. Expected total and differential settlement.
7. Pile and pier foundation information in accordance with Section 1808.2.2.
8. Special design and construction provisions for footings or foundations founded on expansive soils, as necessary.
9. Compacted fill material properties and testing in accordance with Section 1803.5.

SECTION 1803
EXCAVATION, GRADING AND FILL

1803.1 Excavations near footings or foundations. Excavations for any purpose shall not remove lateral support from any footing or foundation without first underpinning or protecting the footing or foundation against settlement or lateral translation.

1803.2 Placement of backfill. The excavation outside the foundation shall be backfilled with soil that is free of organic material, construction debris, cobbles and boulders or a controlled low-strength material (CLSM). The backfill shall be placed in lifts and compacted, in a manner that does not damage the foundation or the waterproofing or dampproofing material.

Exception: Controlled low-strength material need not be compacted.

1803.3 Site grading. The ground immediately adjacent to the foundation shall be sloped away from the building at a slope of not less than one unit vertical in 20 units horizontal (5-percent slope) for a minimum distance of 10 feet (3048 mm) measured perpendicular to the face of the wall. If physical obstructions or lot lines prohibit 10 feet (3048 mm) of horizontal distance, a 5-percent slope shall be provided to an approved alternative method of diverting water away from the foundation. Swales used for this purpose shall be sloped a minimum of 2 percent where located within 10 feet (3048 mm) of the building foundation. Impervious surfaces within 10 feet (3048 mm) of the building foundation shall be sloped a minimum of 2 percent away from the building.

Exception: Where climatic or soil conditions warrant, the slope of the ground away from the building foundation is permitted to be reduced to not less than one unit vertical in 48 units horizontal (2-percent slope).

The procedure used to establish the final ground level adjacent to the foundation shall account for additional settlement of the backfill.

1803.4 Grading and fill in flood hazard areas. See Section 3110.

1803.5 Compacted fill material. Where footings will bear on compacted fill material, the compacted fill shall comply with the provisions of an approved report, which shall contain the following:

1. Specifications for the preparation of the site prior to placement of compacted fill material.
2. Specifications for material to be used as compacted fill.
3. Test method to be used to determine the maximum dry density and optimum moisture content of the material to be used as compacted fill.
4. Maximum allowable thickness of each lift of compacted fill material.
5. Field test method for determining the in-place dry density of the compacted fill.
6. Minimum acceptable in-place dry density expressed as a percentage of the maximum dry density determined in accordance with Item 3.
7. Number and frequency of field tests required to determine compliance with Item 6.

Exception: Compacted fill material less than 12 inches (305 mm) in depth need not comply with an approved report, provided it has been compacted to a minimum of 90 percent Modified Proctor in accordance with ASTM D 1557. The compaction shall be verified by a qualified inspector approved by the building official.

1803.6 Controlled low-strength material (CLSM). Where footings will bear on controlled low-strength material (CLSM), the CLSM shall comply with the provisions of an approved report, which shall contain the following:

1. Specifications for the preparation of the site prior to placement of the CLSM.
2. Specifications for the CLSM.
3. Laboratory or field test method(s) to be used to determine the compressive strength or bearing capacity of the CLSM.
4. Test methods for determining the acceptance of the CLSM in the field.
5. Number and frequency of field tests required to determine compliance with Item 4.

SECTION 1804
ALLOWABLE LOAD-BEARING VALUES OF SOILS

1804.1 Design. The presumptive load-bearing values provided in Table 1804.2 shall be used with the allowable stress design load combinations specified in Section 1605.3.

1804.2 Presumptive load-bearing values. The maximum allowable foundation pressure, lateral pressure or lateral sliding-resistance values for supporting soils near the surface shall not exceed the values specified in Table 1804.2 unless data to substantiate the use of a higher value are submitted and approved.

Presumptive load-bearing values shall apply to materials with similar physical characteristics and dispositions.

Mud, organic silt, organic clays, peat or unprepared fill shall not be assumed to have a presumptive load-bearing capacity unless data to substantiate the use of such a value are submitted.

> **Exception:** A presumptive load-bearing capacity is permitted to be used where the building official deems the load-bearing capacity of mud, organic silt or unprepared fill is adequate for the support of lightweight and temporary structures.

1804.3 Lateral sliding resistance. The resistance of structural walls to lateral sliding shall be calculated by combining the values derived from the lateral bearing and the lateral sliding resistance shown in Table 1804.2 unless data to substantiate the use of higher values are submitted for approval.

For clay, sandy clay, silty clay and clayey silt, in no case shall the lateral sliding resistance exceed one-half the dead load.

1804.3.1 Increases in allowable lateral sliding resistance. The resistance values derived from the table are permitted to be increased by the tabular value for each additional foot (305 mm) of depth to a maximum of 15 times the tabular value.

Isolated poles for uses such as flagpoles or signs and poles used to support buildings that are not adversely affected by a 0.5 inch (12.7 mm) motion at the ground surface due to short-term lateral loads are permitted to be designed using lateral-bearing values equal to two times the tabular values.

SECTION 1805
FOOTINGS AND FOUNDATIONS

1805.1 General. Footings and foundations shall be designed and constructed in accordance with Sections 1805.1 through 1805.9. Footings and foundations shall be built on undisturbed soil, compacted fill material or CLSM. Compacted fill material shall be placed in accordance with Section 1803.5. CLSM shall be placed in accordance with Section 1803.6.

The top surface of footings shall be level. The bottom surface of footings is permitted to have a slope not exceeding one unit vertical in 10 units horizontal (10-percent slope). Footings shall be stepped where it is necessary to change the elevation of the top surface of the footing or where the surface of the ground slopes more than one unit vertical in 10 units horizontal (10-percent slope).

1805.2 Depth of footings. The minimum depth of footings below the undisturbed ground surface shall be 12 inches (305 mm). Where applicable, the depth of footings shall also conform to Sections 1805.2.1 through 1805.2.3.

1805.2.1 Frost protection. Except where otherwise protected from frost, foundation walls, piers and other permanent supports of buildings and structures shall be protected by one or more of the following methods:

1. Extending below the frost line of the locality;
2. Constructing in accordance with ASCE 32; or
3. Erecting on solid rock.

Exception: Free-standing buildings meeting all of the following conditions shall not be required to be protected:

TABLE 1804.2
ALLOWABLE FOUNDATION AND LATERAL PRESSURE

CLASS OF MATERIALS	ALLOWABLE FOUNDATION PRESSURE (psf)[d]	LATERAL BEARING (psf/f below natural grade)[d]	LATERAL SLIDING: Coefficient of friction[a]	LATERAL SLIDING: Resistance (psf)[b]
1. Crystalline bedrock	12,000	1,200	0.70	—
2. Sedimentary and foliated rock	4,000	400	0.35	—
3. Sandy gravel and/or gravel (GW and GP)	3,000	200	0.35	—
4. Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC)	2,000	150	0.25	—
5. Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH and CH)	1,500[c]	100	—	130

For SI: 1 pound per square foot = 0.0479 kPa, 1 pound per square foot per foot = 0.157 kPa/m.

a. Coefficient to be multiplied by the dead load.

b. Lateral sliding resistance value to be multiplied by the contact area, as limited by Section 1804.3.

c. Where the building official determines that in-place soils with an allowable bearing capacity of less than 1,500 psf (72 kPa) are likely to be present at the site, the allowable bearing capacity shall be determined by a soils investigation.

d. An increase of one-third is permitted when using the alternate load combinations in Section 1605.3.2 that include wind loads.

1. Classified in Occupancy Category I, in accordance with Section1604.5;
2. Area of 600 square feet (56 m^2) or less for light-frame construction or 400 square feet (37 m^2) or less for other than light-frame construction; and
3. Eave height of 10 feet (3048 mm) or less.

Footings shall not bear on frozen soil unless such frozen condition is of a permanent character.

1805.2.2 Isolated footings. Footings on granular soil shall be so located that the line drawn between the lower edges of adjoining footings shall not have a slope steeper than 30 degrees (0.52 rad) with the horizontal, unless the material supporting the higher footing is braced or retained or otherwise laterally supported in an approved manner or a greater slope has been properly established by engineering analysis.

1805.2.3 Shifting or moving soils. Where it is known that the shallow subsoils are of a shifting or moving character, footings shall be carried to a sufficient depth to ensure stability.

1805.3 Footings on or adjacent to slopes. The placement of buildings and structures on or adjacent to slopes steeper than one unit vertical in three units horizontal (33.3-percent slope) shall conform to Sections 1805.3.1 through 1805.3.5.

1805.3.1 Building clearance from ascending slopes. In general, buildings below slopes shall be set a sufficient distance from the slope to provide protection from slope drainage, erosion and shallow failures. Except as provided for in Section 1805.3.5 and Figure 1805.3.1, the following criteria will be assumed to provide this protection. Where the existing slope is steeper than one unit vertical in one unit horizontal (100-percent slope), the toe of the slope shall be assumed to be at the intersection of a horizontal plane drawn from the top of the foundation and a plane drawn tangent to the slope at an angle of 45 degrees (0.79 rad) to the horizontal. Where a retaining wall is constructed at the toe of the slope, the height of the slope shall be measured from the top of the wall to the top of the slope.

1805.3.2 Footing setback from descending slope surface. Footings on or adjacent to slope surfaces shall be founded in firm material with an embedment and set back from the slope surface sufficient to provide vertical and lateral support for the footing without detrimental settlement. Except as provided for in Section 1805.3.5 and Figure 1805.3.1, the following setback is deemed adequate to meet the criteria. Where the slope is steeper than 1 unit vertical in 1 unit horizontal (100-percent slope), the required setback shall be measured from an imaginary plane 45 degrees (0.79 rad) to the horizontal, projected upward from the toe of the slope.

1805.3.3 Pools. The setback between pools regulated by this code and slopes shall be equal to one-half the building footing setback distance required by this section. That portion of the pool wall within a horizontal distance of 7 feet (2134 mm) from the top of the slope shall be capable of supporting the water in the pool without soil support.

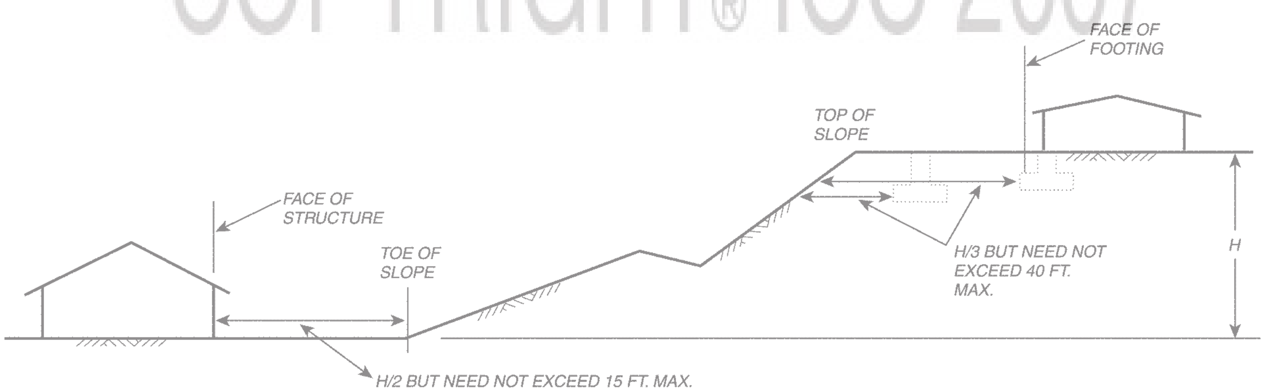
1805.3.4 Foundation elevation. On graded sites, the top of any exterior foundation shall extend above the elevation of the street gutter at point of discharge or the inlet of an approved drainage device a minimum of 12 inches (305 mm) plus 2 percent. Alternate elevations are permitted subject to the approval of the building official, provided it can be demonstrated that required drainage to the point of discharge and away from the structure is provided at all locations on the site.

1805.3.5 Alternate setback and clearance. Alternate setbacks and clearances are permitted, subject to the approval of the building official. The building official is permitted to require an investigation and recommendation of a registered design professional to demonstrate that the intent of this section has been satisfied. Such an investigation shall include consideration of material, height of slope, slope gradient, load intensity and erosion characteristics of slope material.

1805.4 Footings. Footings shall be designed and constructed in accordance with Sections 1805.4.1 through 1805.4.6.

1805.4.1 Design. Footings shall be so designed that the allowable bearing capacity of the soil is not exceeded, and that differential settlement is minimized. The minimum width of footings shall be 12 inches (305 mm).

Footings in areas with expansive soils shall be designed in accordance with the provisions of Section 1805.8.



For SI: 1 foot = 304.8 mm.

FIGURE 1805.3.1
FOUNDATION CLEARANCES FROM SLOPES

1805.4.1.1 Design loads. Footings shall be designed for the most unfavorable effects due to the combinations of loads specified in Section 1605.2 or 1605.3. The dead load is permitted to include the weight of foundations, footings and overlying fill. Reduced live loads, as specified in Sections 1607.9 and 1607.11, are permitted to be used in the design of footings.

1805.4.1.2 Vibratory loads. Where machinery operations or other vibrations are transmitted through the foundation, consideration shall be given in the footing design to prevent detrimental disturbances of the soil.

1805.4.2 Concrete footings. The design, materials and construction of concrete footings shall comply with Sections 1805.4.2.1 through 1805.4.2.6 and the provisions of Chapter 19.

Exception: Where a specific design is not provided, concrete footings supporting walls of light-frame construction are permitted to be designed in accordance with Table 1805.4.2.

1805.4.2.1 Concrete strength. Concrete in footings shall have a specified compressive strength (f'_c) of not less than 2,500 pounds per square inch (psi) (17 237 kPa) at 28 days.

|| **1805.4.2.2 Footing seismic ties.** Reserved.

1805.4.2.3 Plain concrete footings. The edge thickness of plain concrete footings supporting walls of other than light-frame construction shall not be less than 8 inches (203 mm) where placed on soil.

Exception: For plain concrete footings supporting Group R-3 occupancies, the edge thickness is permitted to be 6 inches (152 mm), provided that the footing does not extend beyond a distance greater than the thickness of the footing on either side of the supported wall.

1805.4.2.4 Placement of concrete. Concrete footings shall not be placed through water unless a tremie or other method approved by the building official is used. Where placed under or in the presence of water, the concrete shall be deposited by approved means to ensure minimum segregation of the mix and negligible turbulence of the water.

1805.4.2.5 Protection of concrete. Concrete footings shall be protected from freezing during depositing and for a period of not less than five days thereafter. Water shall not be allowed to flow through the deposited concrete.

1805.4.2.6 Forming of concrete. Concrete footings are permitted to be cast against the earth where, in the opinion of the building official, soil conditions do not require forming. Where forming is required, it shall be in accordance with Chapter 6 of ACI 318.

1805.4.3 Masonry-unit footings. The design, materials and construction of masonry-unit footings shall comply with Sections 1805.4.3.1 and 1805.4.3.2, and the provisions of Chapter 21.

Exception: Where a specific design is not provided, masonry-unit footings supporting walls of light-frame construction are permitted to be designed in accordance with Table 1805.4.2.

1805.4.3.1 Dimensions. Masonry-unit footings shall be laid in Type M or S mortar complying with Section 2103.8 and the depth shall not be less than twice the projection beyond the wall, pier or column. The width shall not be less than 8 inches (203 mm) wider than the wall supported thereon.

1805.4.3.2 Offsets. The maximum offset of each course in brick foundation walls stepped up from the footings shall be 1.5 inches (38 mm) where laid in single courses, and 3 inches (76 mm) where laid in double courses.

1805.4.4 Steel grillage footings. Grillage footings of structural steel shapes shall be separated with approved steel spacers and be entirely encased in concrete with at least 6 inches (152 mm) on the bottom and at least 4 inches (102 mm) at all other points. The spaces between the shapes shall be completely filled with concrete or cement grout.

1805.4.5 Timber footings. Timber footings are permitted for buildings of Type V construction and as otherwise

TABLE 1805.4.2
FOOTINGS SUPPORTING WALLS OF LIGHT-FRAME CONSTRUCTION[a, b, c, d, e]

NUMBER OF FLOORS SUPPORTED BY THE FOOTING[f]	WIDTH OF FOOTING (inches)	THICKNESS OF FOOTING (inches)
1	12	6
2	15	6
3	18	8[g]

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. Depth of footings shall be in accordance with Section 1805.2.

b. The ground under the floor is permitted to be excavated to the elevation of the top of the footing.

c. Interior-stud-bearing walls are permitted to be supported by isolated footings. The footing width and length shall be twice the width shown in this table, and footings shall be spaced not more than 6 feet on center.

d. Reserved. ||

e. For thickness of foundation walls, see Section 1805.5.

f. Footings are permitted to support a roof in addition to the stipulated number of floors. Footings supporting roof only shall be as required for supporting one floor.

g. Plain concrete footings for Group R-3 occupancies are permitted to be 6 inches thick.

approved by the building official. Such footings shall be treated in accordance with AWPA U1 (Commodity Specification A, Use Category 4B). Treated timbers are not required where placed entirely below permanent water level or where used as capping for wood piles that project above the water level over submerged or marsh lands. The compressive stresses perpendicular to the grain in untreated timber footings supported upon treated piles shall not exceed 70 percent of the allowable stresses for the species and grade of timber as specified in the AF&PA NDS.

1805.4.6 Wood foundations. Wood foundation systems shall be designed and installed in accordance with AF&PA Technical Report No. 7. Lumber and plywood shall be treated in accordance with AWPA U1 (Commodity Specification A, Use Category 4B and Section 5.2) and shall be identified in accordance with Section 2303.1.8.1.

1805.5 Foundation walls. Concrete and masonry foundation walls shall be designed in accordance with Chapter 19 or 21, respectively. Foundation walls that are laterally supported at the top and bottom and within the parameters of Tables 1805.5(1) through 1805.5(5) are permitted to be designed and constructed in accordance with Sections 1805.5.1 through 1805.5.5.

1805.5.1 Foundation wall thickness. The minimum thickness of concrete and masonry foundation walls shall comply with Sections 1805.5.1.1 through 1805.5.1.3.

1805.5.1.1 Thickness at top of foundation wall. The thickness of foundation walls shall not be less than the thickness of the wall supported, except that foundation walls of at least 8-inch (203 mm) nominal width are permitted to support brick-veneered frame walls and 10-inch-wide (254 mm) cavity walls provided the requirements of Section 1805.5.1.2 are met. Corbeling of masonry shall be in accordance with Section 2104.2. Where an 8-inch (203 mm) wall is corbeled, the top corbel shall not extend higher than the bottom of the floor framing and shall be a full course of headers at least 6 inches (152 mm) in length or the top course bed joint shall be tied to the vertical wall projection. The tie shall be W2.8 (4.8 mm) and spaced at a maximum horizontal distance of 36 inches (914 mm); the hollow space behind the corbelled masonry shall be filled with mortar or grout.

1805.5.1.2 Thickness based on soil loads, unbalanced backfill height and wall height. The thickness of foundation walls shall comply with the requirements of Table 1805.5(5) for concrete walls, Table 1805.5(1) for plain masonry walls or Table 1805.5(2), 1805.5(3) or 1805.5(4) for masonry walls with reinforcement. When using the tables, masonry shall be laid in running bond and the mortar shall be Type M or S.

Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab on grade is provided and is in contact with the interior surface of the foundation wall, the unbalanced backfill height is permitted to be measured from the exterior finish ground level to the top of the interior concrete slab.

1805.5.1.3 Rubble stone. Foundation walls of rough or random rubble stone shall not be less than 16 inches (406 mm) thick.

1805.5.2 Foundation wall materials. Concrete foundation walls constructed in accordance with Table 1805.5(5) shall comply with Section 1805.5.2.1. Masonry foundation walls constructed in accordance with Table 1805.5(1), 1805.5(2), 1805.5(3) or 1805.5(4) shall comply with Section 1805.5.2.2.

1805.5.2.1 Concrete foundation walls. Concrete foundation walls shall comply with the following:

1. The size and spacing of vertical reinforcement shown in Table 1805.5(5) is based on the use of reinforcement with a minimum yield strength of 60,000 psi (414 MPa). Vertical reinforcement with a minimum yield strength of 40,000 psi (276 MPa) or 50,000 psi (345 MPa) is permitted, provided the same size bar is used and the spacing shown in the table is reduced by multiplying the spacing by 0.67 or 0.83, respectively.
2. Vertical reinforcement, when required, shall be placed nearest the inside face of the wall a distance, *d,* from the outside face (soil side) of the wall. The distance, *d*, is equal to the wall thickness, *t*, minus 1.25 inches (32 mm) plus one-half the bar diameter, d_b [$d = t - (1.25 + d_b/2)$]. The reinforcement shall be placed within a tolerance of $\pm\,^3/_8$ inch (9.5 mm) where *d* is less than or equal to 8 inches (203 mm) or $\pm\,^1/_2$ inch (12.7 mm) where *d* is greater than 8 inches (203 mm).
3. In lieu of the reinforcement shown in Table 1805.5(5), smaller reinforcing bar sizes with closer spacings that provide an equivalent cross-sectional area of reinforcement per unit length of wall are permitted.
4. Concrete cover for reinforcement measured from the inside face of the wall shall not be less than $^3/_4$ inch (19.1 mm). Concrete cover for reinforcement measured from the outside face of the wall shall not be less than 1.5 inches (38 mm) for No. 5 bars and smaller and not less than 2 inches (51 mm) for larger bars.
5. Concrete shall have a specified compressive strength, f_c', of not less than 2,500 psi (17.2 MPa) at 28 days.
6. The unfactored axial load per linear foot of wall shall not exceed 1.2 tf_c', where *t* is the specified wall thickness in inches.

1805.5.2.2 Masonry foundation walls. Masonry foundation walls shall comply with the following:

TABLE 1805.5(1)
PLAIN MASONRY FOUNDATION WALLS[a, b, c]

MAXIMUM WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[e] (feet)	MINIMUM NOMINAL WALL THICKNESS (inches)		
		Soil classes and lateral soil load[a] (psf per foot below natural grade)		
		GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, ML-CL and Inorganic CL soils 60
7	4 (or less)	8	8	8
	5	8	10	10
	6	10	12	10 (solid[c])
	7	12	10 (solid[c])	10 (solid[c])
8	4 (or less)	8	8	8
	5	8	10	12
	6	10	12	12 (solid[c])
	7	12	12 (solid[c])	Note d
	8	10 (solid[c])	12 (solid[c])	Note d
9	4 (or less)	8	8	8
	5	8	10	12
	6	12	12	12 (solid[c])
	7	12 (solid[c])	12 (solid[c])	Note d
	8	12 (solid[c])	Note d	Note d
	9	Note d	Note d	Note d

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/m.

a. For design lateral soil loads, see Section 1610. Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist soil conditions without hydrostatic pressure.

b. Provisions for this table are based on construction requirements specified in Section 1805.5.2.2.

c. Solid grouted hollow units or solid masonry units.

d. A design in compliance with Chapter 21 or reinforcement in accordance with Table 1805.5(2) is required.

e. For height of unbalanced backfill, see Section 1805.5.1.2.

TABLE 1805.5(2)
8-INCH MASONRY FOUNDATION WALLS WITH REINFORCEMENT WHERE d ≥ 5 INCHES[a, b, c]

MAXIMUM WALL HEIGHT (feet-inches)	MAXIMUM UNBALANCED BACKFILL HEIGHT[d] (feet-inches)	VERTICAL REINFORCEMENT		
		Soil classes and lateral soil load[a] (psf per foot below natural grade)		
		GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, ML-CL and Inorganic CL soils 60
7-4	4-0 (or less)	#4 at 48″ o.c.	#4 at 48″ o.c.	#4 at 48″ o.c.
	5-0	#4 at 48″ o.c.	#4 at 48″ o.c.	#4 at 48″ o.c.
	6-0	#4 at 48″ o.c.	#5 at 48″ o.c.	#5 at 48″ o.c.
	7-4	#5 at 48″ o.c.	#6 at 48″ o.c.	#7 at 48″ o.c.
8-0	4-0 (or less)	#4 at 48″ o.c.	#4 at 48″ o.c.	#4 at 48″ o.c.
	5-0	#4 at 48″ o.c.	#4 at 48″ o.c.	#4 at 48″ o.c.
	6-0	#4 at 48″ o.c.	#5 at 48″ o.c.	#5 at 48″ o.c.
	7-0	#5 at 48″ o.c.	#6 at 48″ o.c.	#7 at 48″ o.c.
	8-0	#5 at 48″ o.c.	#6 at 48″ o.c.	#7 at 48″ o.c.
8-8	4-0 (or less)	#4 at 48″ o.c.	#4 at 48″ o.c.	#4 at 48″ o.c.
	5-0	#4 at 48″ o.c.	#4 at 48″ o.c.	#5 at 48″ o.c.
	6-0	#4 at 48″ o.c.	#5 at 48″ o.c.	#6 at 48″ o.c.
	7-0	#5 at 48″ o.c.	#6 at 48″ o.c.	#7 at 48″ o.c.
	8-8	#6 at 48″ o.c.	#7 at 48″ o.c.	#8 at 48″ o.c.
9-4	4-0 (or less)	#4 at 48″ o.c.	#4 at 48″ o.c.	#4 at 48″ o.c.
	5-0	#4 at 48″ o.c.	#4 at 48″ o.c.	#5 at 48″ o.c.
	6-0	#4 at 48″ o.c.	#5 at 48″ o.c.	#6 at 48″ o.c.
	7-0	#5 at 48″ o.c.	#6 at 48″ o.c.	#7 at 48″ o.c.
	8-0	#6 at 48″ o.c.	#7 at 48″ o.c.	#8 at 48″ o.c.
	9-4	#7 at 48″ o.c.	#8 at 48″ o.c.	#9 at 48″ o.c.
10-0	4-0 (or less)	#4 at 48″ o.c.	#4 at 48″ o.c.	#4 at 48″ o.c.
	5-0	#4 at 48″ o.c.	#4 at 48″ o.c.	#5 at 48″ o.c.
	6-0	#4 at 48″ o.c.	#5 at 48″ o.c.	#6 at 48″ o.c.
	7-0	#5 at 48″ o.c.	#6 at 48″ o.c.	#7 at 48″ o.c.
	8-0	#6 at 48″ o.c.	#7 at 48″ o.c.	#8 at 48″ o.c.
	9-0	#7 at 48″ o.c.	#8 at 48″ o.c.	#9 at 48″ o.c.
	10-0	#7 at 48″ o.c.	#9 at 48″ o.c.	#9 at 48″ o.c.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/m.

a. For design lateral soil loads, see Section 1610. Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist soil conditions without hydrostatic pressure.

b. Provisions for this table are based on construction requirements specified in Section 1805.5.2.2.

c. For alternative reinforcement, see Section 1805.5.3.

d. For height of unbalanced backfill, see Section 1805.5.1.2.

TABLE 1805.5(3)
10-INCH MASONRY FOUNDATION WALLS WITH REINFORCEMENT WHERE d ≥ 6.75 INCHES[a, b, c]

MAXIMUM WALL HEIGHT (feet-inches)	MAXIMUM UNBALANCED BACKFILL HEIGHT[d] (feet-inches)	VERTICAL REINFORCEMENT — Soil classes and lateral soil load[a] (psf per foot below natural grade): GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, ML-CL and Inorganic CL soils 60
7-4	4-0 (or less)	#4 at 56″ o.c.	#4 at 56″ o.c.	#4 at 56″ o.c.
	5-0	#4 at 56″ o.c.	#4 at 56″ o.c.	#4 at 56″ o.c.
	6-0	#4 at 56″ o.c.	#4 at 56″ o.c.	#5 at 56″ o.c.
	7-4	#4 at 56″ o.c.	#5 at 56″ o.c.	#6 at 56″ o.c.
8-0	4-0 (or less)	#4 at 56″ o.c.	#4 at 56″ o.c.	#4 at 56″ o.c.
	5-0	#4 at 56″ o.c.	#4 at 56″ o.c.	#4 at 56″ o.c.
	6-0	#4 at 56″ o.c.	#4 at 56″ o.c.	#5 at 56″ o.c.
	7-0	#4 at 56″ o.c.	#5 at 56″ o.c.	#6 at 56″ o.c.
	8-0	#5 at 56″ o.c.	#6 at 56″ o.c.	#7 at 56″ o.c.
8-8	4-0 (or less)	#4 at 56″ o.c.	#4 at 56″ o.c.	#4 at 56″ o.c.
	5-0	#4 at 56″ o.c.	#4 at 56″ o.c.	#4 at 56″ o.c.
	6-0	#4 at 56″ o.c.	#4 at 56″ o.c.	#5 at 56″ o.c.
	7-0	#4 at 56″ o.c.	#5 at 56″ o.c.	#6 at 56″ o.c.
	8-8	#5 at 56″ o.c.	#7 at 56″ o.c.	#8 at 56″ o.c.
9-4	4-0 (or less)	#4 at 56″ o.c.	#4 at 56″ o.c.	#4 at 56″ o.c.
	5-0	#4 at 56″ o.c.	#4 at 56″ o.c.	#4 at 56″ o.c.
	6-0	#4 at 56″ o.c.	#5 at 56″ o.c.	#5 at 56″ o.c.
	7-0	#4 at 56″ o.c.	#5 at 56″ o.c.	#6 at 56″ o.c.
	8-0	#5 at 56″ o.c.	#6 at 56″ o.c.	#7 at 56″ o.c.
	9-4	#6 at 56″ o.c.	#7 at 56″ o.c.	#8 at 56″ o.c.
10-0	4-0 (or less)	#4 at 56″ o.c.	#4 at 56″ o.c.	#4 at 56″ o.c.
	5-0	#4 at 56″ o.c.	#4 at 56″ o.c.	#4 at 56″ o.c.
	6-0	#4 at 56″ o.c.	#5 at 56″ o.c.	#5 at 56″ o.c.
	7-0	#5 at 56″ o.c.	#6 at 56″ o.c.	#7 at 56″ o.c.
	8-0	#5 at 56″ o.c.	#7 at 56″ o.c.	#8 at 56″ o.c.
	9-0	#6 at 56″ o.c.	#7 at 56″ o.c.	#9 at 56″ o.c.
	10-0	#7 at 56″ o.c.	#8 at 56″ o.c.	#9 at 56″ o.c.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/m.

a. For design lateral soil loads, see Section 1610. Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist soil conditions without hydrostatic pressure.

b. Provisions for this table are based on construction requirements specified in Section 1805.5.2.2.

c. For alternative reinforcement, see Section 1805.5.3.

d. For height of unbalanced fill, see Section 1805.5.1.2.

TABLE 1805.5(4)
12-INCH MASONRY FOUNDATION WALLS WITH REINFORCEMENT WHERE d ≥ 8.75 INCHES[a, b, c]

MAXIMUM WALL HEIGHT (feet-inches)	MAXIMUM UNBALANCED BACKFILL HEIGHT[d] (feet-inches)	VERTICAL REINFORCEMENT — Soil classes and lateral soil load[a] (psf per foot below natural grade): GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, ML-CL and Inorganic CL soils 60
7-4	4-0 (or less)	#4 at 72″ o.c.	#4 at 72″ o.c.	#4 at 72″ o.c.
	5-0	#4 at 72″ o.c.	#4 at 72″ o.c.	#4 at 72″ o.c.
	6-0	#4 at 72″ o.c.	#4 at 72″ o.c.	#5 at 72″ o.c.
	7-4	#4 at 72″ o.c.	#5 at 72″ o.c.	#6 at 72″ o.c.
8-0	4-0 (or less)	#4 at 72″ o.c.	#4 at 72″ o.c.	#4 at 72″ o.c.
	5-0	#4 at 72″ o.c.	#4 at 72″ o.c.	#4 at 72″ o.c.
	6-0	#4 at 72″ o.c.	#4 at 72″ o.c.	#5 at 72″ o.c.
	7-0	#4 at 72″ o.c.	#5 at 72″ o.c.	#6 at 72″ o.c.
	8-0	#5 at 72″ o.c.	#6 at 72″ o.c.	#7 at 72″ o.c.
8-8	4-0 (or less)	#4 at 72″ o.c.	#4 at 72″ o.c.	#4 at 72″ o.c.
	5-0	#4 at 72″ o.c.	#4 at 72″ o.c.	#4 at 72″ o.c.
	6-0	#4 at 72″ o.c.	#4 at 72″ o.c.	#5 at 72″ o.c.
	7-0	#4 at 72″ o.c.	#5 at 72″ o.c.	#6 at 72″ o.c.
	8-8	#5 at 72″ o.c.	#7 at 72″ o.c.	#8 at 72″ o.c.
9-4	4-0 (or less)	#4 at 72″ o.c.	#4 at 72″ o.c.	#4 at 72″ o.c.
	5-0	#4 at 72″ o.c.	#4 at 72″ o.c.	#4 at 72″ o.c.
	6-0	#4 at 72″ o.c.	#5 at 72″ o.c.	#5 at 72″ o.c.
	7-0	#4 at 72″ o.c.	#5 at 72″ o.c.	#6 at 72″ o.c.
	8-0	#5 at 72″ o.c.	#6 at 72″ o.c.	#7 at 72″ o.c.
	9-4	#6 at 72″ o.c.	#7 at 72″ o.c.	#8 at 72″ o.c.
10-0	4-0 (or less)	#4 at 72″ o.c.	#4 at 72″ o.c.	#4 at 72″ o.c.
	5-0	#4 at 72″ o.c.	#4 at 72″ o.c.	#4 at 72″ o.c.
	6-0	#4 at 72″ o.c.	#5 at 72″ o.c.	#5 at 72″ o.c.
	7-0	#4 at 72″ o.c.	#6 at 72″ o.c.	#6 at 72″ o.c.
	8-0	#5 at 72″ o.c.	#6 at 72″ o.c.	#7 at 72″ o.c.
	9-0	#6 at 72″ o.c.	#7 at 72″ o.c.	#8 at 72″ o.c.
	10-0	#7 at 72″ o.c.	#8 at 72″ o.c.	#9 at 72″ o.c.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/m.

a. For design lateral soil loads, see Section 1610. Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist soil conditions without hydrostatic pressure.

b. Provisions for this table are based on construction requirements specified in Section 1805.5.2.2.

c. For alternative reinforcement, see Section 1805.5.3.

d. For height of unbalanced backfill, see Section 1805.5.1.2.

TABLE 1805.5(5)
CONCRETE FOUNDATION WALLS[b, c]

MAXIMUM WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[e] (feet)	VERTICAL REINFORCEMENT AND SPACING (inches)								
		Design lateral soil load[a] (psf per foot of depth)								
		30			45			60		
		Minimum wall thickness (inches)								
		7.5	9.5	11.5	7.5	9.5	11.5	7.5	9.5	11.5
5	4	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	PC
6	4	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	PC
	6	PC	PC	PC	PC	PC	PC	PC	PC	PC
7	4	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	PC
	6	PC	PC	PC	PC	PC	PC	#5 at 48″	PC	PC
	7	PC	PC	PC	#5 at 46″	PC	PC	#6 at 48″	PC	PC
8	4	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	PC
	6	PC	PC	PC	PC	PC	PC	#5 at 43″	PC	PC
	7	PC	PC	PC	#5 at 41″	PC	PC	#6 at 43″	PC	PC
	8	#5 at 47″	PC	PC	#6 at 43″	PC	PC	#6 at 32″	#6 at 44″	PC
9	4	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	PC
	6	PC	PC	PC	PC	PC	PC	#5 at 39″	PC	PC
	7	PC	PC	PC	#5 at 37″	PC	PC	#6 at 38″	#5 at 37″	PC
	8	#5 at 41″	PC	PC	#6 at 38″	#5 at 37″	PC	#7 at 39″	#6 at 39″	#4 at 48″
	9[d]	#6 at 46″	PC	PC	#7 at 41″	#6 at 41″	PC	#7 at 31″	#7 at 41″	#6 at 39″
10	4	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	PC
	6	PC	PC	PC	PC	PC	PC	#5 at 37″	PC	PC
	7	PC	PC	PC	#6 at 48″	PC	PC	#6 at 35″	#6 at 48″	PC
	8	#5 at 38″	PC	PC	#7 at 47″	#6 at 47″	PC	#7 at 35″	#7 at 48″	#6 at 45″
	9[d]	#6 at 41″	#4 at 48″	PC	#7 at 37″	#7 at 48″	#4 at 48″	#6 at 22″	#7 at 37″	#7 at 47″
	10[d]	#7 at 45″	#6 at 45″	PC	#7 at 31″	#7 at 40″	#6 at 38″	#6 at 22″	#7 at 30″	#7 at 38″

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.157 kPa/m.

a. For design lateral soil loads for different classes of soil, see Section 1610.

b. Provisions for this table are based on construction requirements specified in Section 1805.5.2.1.

c. "PC" means plain concrete.

d. Where design lateral soil loads from Table 1610.1 are used, the requirements for 30 and 45 psf per foot of depth are not applicable. See Section 1610.

e. For height of unbalanced backfill, see Section 1805.5.1.2.

1. Vertical reinforcement shall have a minimum yield strength of 60,000 psi (414 MPa).
2. The specified location of the reinforcement shall equal or exceed the effective depth distance, *d*, noted in Tables 1805.5(2), 1805.5(3) and 1805.5(4) and shall be measured from the face of the exterior (soil) side of the wall to the center of the vertical reinforcement. The reinforcement shall be placed within the tolerances specified in ACI 530.1/ASCE 6/TMS 402, Article 3.4 B7 of the specified location.
3. Grout shall comply with Section 2103.12.
4. Concrete masonry units shall comply with ASTM C 90.
5. Clay masonry units shall comply with ASTM C 652 for hollow brick, except compliance with ASTM C 62 or ASTM C 216 is permitted when solid masonry units are installed in accordance with Table 1805.5(1) for plain masonry.
6. Masonry units shall be installed with Type M or S mortar in accordance with Section 2103.8.
7. The unfactored axial load per linear foot of wall shall not exceed 1.2 tf'_m where t is the specified well thickness in inches and f'_m is the specified compressive strength of masonry in pounds per square inch.

1805.5.3 Alternative foundation wall reinforcement. In lieu of the reinforcement provisions for masonry foundation walls in Table 1805.5(2), 1805.5(3) or 1805.5(4), alternative reinforcing bar sizes and spacings having an equivalent cross-sectional area of reinforcement per linear foot (mm) of wall are permitted to be used, provided the spacing of reinforcement does not exceed 72 inches (1829 mm) and reinforcing bar sizes do not exceed No. 11.

1805.5.4 Hollow masonry walls. At least 4 inches (102 mm) of solid masonry shall be provided at girder supports at the top of hollow masonry unit foundation walls.

1805.5.5 Seismic requirements. Reserved.

1805.5.5.1 Seismic requirements for concrete foundations. Reserved.

1805.5.5.2 Seismic requirements for masonry foundation walls. Reserved.

1805.5.6 Foundation wall drainage. Foundation walls shall be designed to support the weight of the full hydrostatic pressure of undrained backfill unless a drainage system is installed in accordance with Sections 1807.4.2 and 1807.4.3.

1805.5.7 Pier and curtain wall foundations. In regions where the basic wind speed is 100 mph or less, pier and curtain wall foundations are permitted to be used to support light-frame construction not more than two stories in height, provided the following requirements are met:

1. All load-bearing walls shall be placed on continuous concrete footings bonded integrally with the exterior wall footings.
2. The minimum actual thickness of a load-bearing masonry wall shall not be less than 4 inches (102 mm) nominal or 3.625 inches (92 mm) actual thickness, and shall be bonded integrally with piers spaced 6 feet (1829 mm) on center (o.c.).
3. Piers shall be constructed in accordance with Chapter 21 and the following:
   - 3.1. The unsupported height of the masonry piers shall not exceed 10 times their least dimension.
   - 3.2. Where structural clay tile or hollow concrete masonry units are used for piers supporting beams and girders, the cellular spaces shall be filled solidly with concrete or Type M or S mortar.

     Exception: Unfilled hollow piers are permitted where the unsupported height of the pier is not more than four times its least dimension.
   - 3.3. Hollow piers shall be capped with 4 inches (102 mm) of solid masonry or concrete or the cavities of the top course shall be filled with concrete or grout.
4. The maximum height of a 4-inch (102 mm) load-bearing masonry foundation wall supporting wood frame walls and floors shall not be more than 4 feet (1219 mm) in height.
5. The unbalanced fill for 4-inch (102 mm) foundation walls shall not exceed 24 inches (610 mm) for solid masonry, nor 12 inches (305 mm) for hollow masonry.

1805.6 Foundation plate or sill bolting. Wood foundation plates or sills shall be bolted or strapped to the foundation or foundation wall as provided in Chapter 23.

1805.7 Designs employing lateral bearing. Designs to resist both axial and lateral loads employing posts or poles as columns embedded in earth or embedded in concrete footings in the earth shall conform to the requirements of Sections 1805.7.1 through 1805.7.3.

1805.7.1 Limitations. The design procedures outlined in this section are subject to the following limitations:

1. The frictional resistance for structural walls and slabs on silts and clays shall be limited to one-half of the normal force imposed on the soil by the weight of the footing or slab.
2. Posts embedded in earth shall not be used to provide lateral support for structural or nonstructural materials such as plaster, masonry or concrete unless bracing is provided that develops the limited deflection required.

Wood poles shall be treated in accordance with AWPA U1 for sawn timber posts (Commodity Specification A, Use Category 4B) and for round timber posts (Commodity Specification B, Use Category 4B).

1805.7.2 Design criteria. The depth to resist lateral loads shall be determined by the design criteria established in Sections 1805.7.2.1 through 1805.7.2.3, or by other methods approved by the building official.

1805.7.2.1 Nonconstrained. The following formula shall be used in determining the depth of embedment required to resist lateral loads where no constraint is provided at the ground surface, such as rigid floor or rigid ground surface pavement, and where no lateral constraint is provided above the ground surface, such as a structural diaphragm.

$$d = 0.5A\{1 + [1 + (4.36h/A)]^{1/2}\} \qquad \textbf{(Equation 18-1)}$$

where:

A = $2.34P/S_1\,b$.

b = Diameter of round post or footing or diagonal dimension of square post or footing, feet (m).

d = Depth of embedment in earth in feet (m) but not over 12 feet (3658 mm) for purpose of computing lateral pressure.

h = Distance in feet (m) from ground surface to point of application of "P."

P = Applied lateral force in pounds (kN).

S_1 = Allowable lateral soil-bearing pressure as set forth in Section 1804.3 based on a depth of one-third the depth of embedment in pounds per square foot (psf) (kPa).

1805.7.2.2 Constrained. The following formula shall be used to determine the depth of embedment required to resist lateral loads where constraint is provided at the ground surface, such as a rigid floor or pavement.

$$d^2 = 4.25(Ph/S_3\,b) \qquad \textbf{(Equation 18-2)}$$

or alternatively

$$d^2 = 4.25\,(M_g/S_3\,b) \qquad \textbf{(Equation 18-3)}$$

where:

M_g = Moment in the post at grade, in foot-pounds (kN-m).

S_3 = Allowable lateral soil-bearing pressure as set forth in Section 1804.3 based on a depth equal to the depth of embedment in pounds per square foot (kPa).

1805.7.2.3 Vertical load. The resistance to vertical loads shall be determined by the allowable soil-bearing pressure set forth in Table 1804.2.

1805.7.3 Backfill. The backfill in the annular space around columns not embedded in poured footings shall be by one of the following methods:

1. Backfill shall be of concrete with an ultimate strength of 2,000 psi (13.8 MPa) at 28 days. The hole shall not be less than 4 inches (102 mm) larger than the diameter of the column at its bottom or 4 inches (102 mm) larger than the diagonal dimension of a square or rectangular column.
2. Backfill shall be of clean sand. The sand shall be thoroughly compacted by tamping in layers not more than 8 inches (203 mm) in depth.
3. Backfill shall be of controlled low-strength material (CLSM).

1805.8 Design for expansive soils. Footings or foundations for buildings and structures founded on expansive soils shall be designed in accordance with Section 1805.8.1 or 1805.8.2.

Footing or foundation design need not comply with Section 1805.8.1 or 1805.8.2 where the soil is removed in accordance with Section 1805.8.3, nor where the building official approves stabilization of the soil in accordance with Section 1805.8.4.

1805.8.1 Foundations. Footings or foundations placed on or within the active zone of expansive soils shall be designed to resist differential volume changes and to prevent structural damage to the supported structure. Deflection and racking of the supported structure shall be limited to that which will not interfere with the usability and serviceability of the structure.

Foundations placed below where volume change occurs or below expansive soil shall comply with the following provisions:

1. Foundations extending into or penetrating expansive soils shall be designed to prevent uplift of the supported structure.
2. Foundations penetrating expansive soils shall be designed to resist forces exerted on the foundation due to soil volume changes or shall be isolated from the expansive soil.

1805.8.2 Slab-on-ground foundations. Moments, shears and deflections for use in designing slab-on-ground, mat or raft foundations on expansive soils shall be determined in accordance with *WRI/CRSI Design of Slab-on-Ground Foundations* or *PTI Standard Requirements for Analysis of Shallow Concrete Foundations on Expansive Soils.* Using the moments, shears and deflections determined above, nonprestressed slabs-on-ground, mat or raft foundations on expansive soils shall be designed in accordance with *WRI/CRSI Design of Slab-on-Ground Foundations* and post-tensioned slab-on-ground, mat or raft foundations on expansive soils shall be designed in accordance with *PTI Standard Requirements for Design of Shallow Post-Tensioned Concrete Foundations on Expansive Soils*. It shall be permitted to analyze and design such slabs by other methods that account for soil-structure interaction, the deformed shape of the soil support, the plate or stiffened plate action of the slab as well as both center lift and edge lift conditions. Such alternative methods shall be rational and the basis for all aspects and parameters of the method shall be available for peer review.

1805.8.3 Removal of expansive soil. Where expansive soil is removed in lieu of designing footings or foundations in accordance with Section 1805.8.1 or 1805.8.2, the soil shall be removed to a depth sufficient to ensure a constant moisture content in the remaining soil. Fill material shall not contain expansive soils and shall comply with Section 1803.5 or 1803.6.

Exception: Expansive soil need not be removed to the depth of constant moisture, provided the confining pressure in the expansive soil created by the fill and supported structure exceeds the swell pressure.

1805.8.4 Stabilization. Where the active zone of expansive soils is stabilized in lieu of designing footings or foundations in accordance with Section 1805.8.1 or 1805.8.2, the soil shall be stabilized by chemical, dewatering, presaturation or equivalent techniques.

1805.9 Seismic requirements. Reserved.

SECTION 1806
RETAINING WALLS

1806.1 General. Walls built to retain or support the lateral pressure of earth or water or other superimposed loads shall be designed and constructed of masonry, concrete, steel sheet piling or other approved materials.

1806.2 Design. Retaining walls shall be designed to resist the design lateral soil loads in Section 1610, including both dead and live load surcharges to which such walls are subjected, and to ensure stability against overturning, sliding, excessive foundation pressure and water uplift.

1806.3 Hydrostatic pressure. Unless drainage is provided, the hydrostatic head of the water pressure shall be assumed to be equal to the height of the wall.

1806.4 Reinforced masonry retaining walls. Vertical reinforcement for masonry retaining walls shall comply with Table 1806.4 or shall be designed in accordance with ACI 530/ASCE 5/TMS 402. Masonry shall be fully grouted with a minimum f'_m of 1,500 psi (10 343 kPa). Mortar for masonry shall be Type M or S and laid in running bond. The specified location of the reinforcement shall equal or exceed the effective depth distance, d, noted in Table 1806.4 and shall be measured from the exposed side of the wall to the center of the vertical reinforcement. Footings for reinforced masonry retaining walls shall be designed in accordance with ACI 318.

1806.5 Segmental retaining walls. Segmental retaining walls shall be designed in accordance with NCMA Design Manual for Segmental Retaining Walls.

SECTION 1807
DAMPPROOFING AND WATERPROOFING

1807.1 Where required. Walls or portions thereof that retain earth and enclose interior spaces and floors below grade shall be waterproofed and dampproofed in accordance with this section, with the exception of those spaces containing groups other than residential and institutional where such omission is not detrimental to the building or occupancy.

Ventilation for crawl spaces shall comply with Section 1203.4.

1807.1.1 Story above grade plane. Where a basement is considered a story above grade plane and the finished ground level adjacent to the basement wall is below the basement floor elevation for 25 percent or more of the perimeter, the floor and walls shall be dampproofed in accordance with Section 1807.2 and a foundation drain shall be installed in accordance with Section 1807.4.2. The foundation drain shall be installed around the portion of the perimeter where the basement floor is below ground level. The provisions of Sections 1802.2.3, 1807.3 and 1807.4.1 shall not apply in this case.

1807.1.2 Under-floor space. The finished ground level of an under-floor space such as a crawl space shall not be located below the bottom of the footings. Where there is evidence that the ground-water table rises to within 6 inches (152 mm) of the ground level at the outside building perimeter, or that the surface water does not readily drain from the building site, the ground level of the under-floor space shall be as high as the outside finished ground level, unless an approved drainage system is provided. The provisions of Sections 1802.2.3, 1807.2, 1807.3 and 1807.4 shall not apply in this case.

1807.1.2.1 Flood hazard areas. See Section 3110.

1807.1.3 Ground-water control. Where the ground-water table is lowered and maintained at an elevation not less than 6 inches (152 mm) below the bottom of the lowest floor, the floor and walls shall be dampproofed in accordance with Section 1807.2. The design of the system to lower the ground-water table shall be based on accepted principles of engineering that shall consider, but not necessarily be limited to, permeability of the soil, rate at which water enters the drainage system, rated capacity of pumps, head against which pumps are to operate and the rated capacity of the disposal area of the system.

1807.2 Dampproofing required. Where hydrostatic pressure will not occur as determined by Section 1802.2.3, floors and walls for other than wood foundation systems shall be dampproofed in accordance with this section. Wood foundation systems shall be constructed in accordance with AF&PA Technical Report No. 7.

1807.2.1 Floors. Dampproofing materials for floors shall be installed between the floor and the base course required by Section 1807.4.1, except where a separate floor is provided above a concrete slab.

Where installed beneath the slab, dampproofing shall consist of not less than 6-mil (0.006 inch; 0.152 mm) polyethylene with joints lapped not less than 6 inches (152 mm), or other approved methods or materials. Where permitted to be installed on top of the slab, dampproofing shall consist of mopped-on bitumen, not less than 4-mil (0.004 inch; 0.102 mm) polyethylene, or other approved methods or materials. Joints in the membrane shall be lapped and sealed in accordance with the manufacturer's installation instructions.

1807.2.2 Walls. Dampproofing materials for walls shall be installed on the exterior surface of the wall, and shall extend from the top of the footing to above ground level.

TABLE 1806.4
REINFORCEMENT FOR MASONRY RETAINING WALLS[a]

Nominal Wall thickness [(in.) (mm)]	Wall depth, H, ft (m)	Reinforcement size & spacing for equivalent fluid weight of soil, pcf (kN/m3), of:		
		30 (4.7)	45 (7.1)	60 (9.4)
8 (203)	4.0 (1.2)	#4 at 64 in.	#4 at 40 in.	#4 at 32 in.
	4.7 (1.4)	#4 at 40 in.	#4 at 24 in.	#4 at 16 in.
	5.3 (1.6)	#4 at 24 in.	#4 at 16 in.	#5 at 16 in.
	6.0 (1.8)	#5 at 24 in.	#6 at 16 in.	#8 at 16 in.
	6.7 (2.0)	#5 at 16 in.	#6 at 8 in.	—
10 (254)	4.0 (1.2)	#4 at 72 in.	#4 at 64 in.	#4 at 48 in.
	4.7 (1.4)	#4 at 56 in.	#4 at 40 in.	#4 at 24 in.
	5.3 (1.6)	#4 at 40 in.	#4 at 24 in.	#4 at 16 in.
	6.0 (1.8)	#4 at 24 in.	#4 at 16 in.	#5 at 16 in.
	6.7 (2.0)	#4 at 16 in.	#5 at 16 in.	#6 at 16 in.
	7.3 (2.2)	#5 at 24 in.	#6 at 16 in.	#6 at 8 in.
	8.0 (2.4)	#5 at 16 in.	#6 at 8 in.	—
12 (305)	4.0 (1.2)	#4 at 72 in.	#4 at 72 in.	#4 at 64 in.
	4.7 (1.4)	#4 at 72 in.	#4 at 48 in.	#4 at 40 in.
	5.3 (1.6)	#4 at 48 in.	#4 at 32 in.	#4 at 24 in.
	6.0 (1.8)	#4 at 32 in.	#4 at 24 in.	#4 at 16 in.
	6.7 (2.0)	#4 at 24 in.	#4 at 16 in.	#5 at 16 in.
	7.3 (2.2)	#4 at 16 in.	#5 at 16 in.	#6 at 16 in.
	8.0 (2.4)	#5 at 24 in.	#5 at 16 in.	#7 at 16 in.
	8.7 (2.7)	#5 at 16 in.	#7 at 16 in.	#7 at 8 in.
	9.3 (2.8)	#6 at 16 in.	#7 at 8 in.	—

a. Based on fully grouted masonry; f'_m = 1500 psi (10.3 MPa); d = 5 in., 7 in. and 9 in. (127, 178 and 229 mm) for wall thicknesses of 8, 10, and 12 in. (203, 254, and 305 mm), respectively; level backfill to top of wall.

Dampproofing shall consist of a bituminous material, 3 pounds per square yard (16 N/m^2) of acrylic modified cement, 0.125 inch (3.2 mm) coat of surface-bonding mortar complying with ASTM C 887, any of the materials permitted for waterproofing by Section 1807.3.2 or other approved methods or materials.

1807.2.2.1 Surface preparation of walls. Prior to application of dampproofing materials on concrete walls, holes and recesses resulting from the removal of form ties shall be sealed with a bituminous material or other approved methods or materials. Unit masonry walls shall be parged on the exterior surface below ground level with not less than 0.375 inch (9.5 mm) of portland cement mortar. The parging shall be coved at the footing.

Exception: Parging of unit masonry walls is not required where a material is approved for direct application to the masonry.

1807.3 Waterproofing required. Where the ground-water investigation required by Section 1802.2.3 indicates that a hydrostatic pressure condition exists, and the design does not include a ground-water control system as described in Section 1807.1.3, walls and floors shall be waterproofed in accordance with this section.

1807.3.1 Floors. Floors required to be waterproofed shall be of concrete and designed and constructed to withstand the hydrostatic pressures to which the floors will be subjected.

Waterproofing shall be accomplished by placing a membrane of rubberized asphalt, butyl rubber, fully adhered/fully bonded HDPE or polyolefin composite membrane or not less than 6-mil [0.006 inch (0.152 mm)] polyvinyl chloride with joints lapped not less than 6 inches (152 mm) or other approved materials under the slab. Joints in the membrane shall be lapped and sealed in accordance with the manufacturer's installation instructions.

1807.3.2 Walls. Walls required to be waterproofed shall be of concrete or masonry and shall be designed and constructed to withstand the hydrostatic pressures and other lateral loads to which the walls will be subjected.

Waterproofing shall be applied from the bottom of the wall to not less than 12 inches (305 mm) above the maximum elevation of the ground-water table. The remainder of the wall shall be dampproofed in accordance with Section 1807.2.2. Waterproofing shall consist of two-ply hot-mopped felts, not less than 6-mil (0.006 inch; 0.152 mm) polyvinyl chloride, 40-mil (0.040 inch; 1.02 mm) polymer-modified asphalt, 6-mil (0.006 inch; 0.152 mm) polyethylene or other approved methods or materials capable of bridging nonstructural cracks. Joints in the membrane shall be lapped and sealed in accordance with the manufacturer's installation instructions.

1807.3.2.1 Surface preparation of walls. Prior to the application of waterproofing materials on concrete or masonry walls, the walls shall be prepared in accordance with Section 1807.2.2.1.

1807.3.3 Joints and penetrations. Joints in walls and floors, joints between the wall and floor and penetrations of the wall and floor shall be made water-tight utilizing approved methods and materials.

1807.4 Subsoil drainage system. Where a hydrostatic pressure condition does not exist, dampproofing shall be provided and a base shall be installed under the floor and a drain installed around the foundation perimeter. A subsoil drainage system designed and constructed in accordance with Section 1807.1.3 shall be deemed adequate for lowering the ground-water table.

1807.4.1 Floor base course. Floors of basements, except as provided for in Section 1807.1.1, shall be placed over a floor base course not less than 4 inches (102 mm) in thickness that consists of gravel or crushed stone containing not more than 10 percent of material that passes through a No. 4 (4.75 mm) sieve.

Exception: Where a site is located in well-drained gravel or sand/gravel mixture soils, a floor base course is not required.

1807.4.2 Foundation drain. A drain shall be placed around the perimeter of a foundation that consists of gravel or crushed stone containing not more than 10-percent material that passes through a No. 4 (4.75 mm) sieve. The drain shall extend a minimum of 12 inches (305 mm) beyond the outside edge of the footing. The thickness shall be such that the bottom of the drain is not higher than the bottom of the base under the floor, and that the top of the drain is not less than 6 inches (152 mm) above the top of the footing. The top of the drain shall be covered with an approved filter membrane material. Where a drain tile or perforated pipe is used, the invert of the pipe or tile shall not be higher than the floor elevation. The top of joints or the top of perforations shall be protected with an approved filter membrane material. The pipe or tile shall be placed on not less than 2 inches (51 mm) of gravel or crushed stone complying with Section 1807.4.1, and shall be covered with not less than 6 inches (152 mm) of the same material.

1807.4.3 Drainage discharge. The floor base and foundation perimeter drain shall discharge by gravity or mechanical means into an approved drainage system that complies with the *Florida Building Code, Plumbing*.

Exception: Where a site is located in well-drained gravel or sand/gravel mixture soils, a dedicated drainage system is not required.

SECTION 1808
PIER AND PILE FOUNDATIONS

1808.1 Definitions. The following words and terms shall, for the purposes of this section, have the meanings shown herein.

FLEXURAL LENGTH. Flexural length is the length of the pile from the first point of zero lateral deflection to the underside of the pile cap or grade beam.

MICROPILES. Micropiles are 12-inch-diameter (305 mm) or less bored, grouted-in-place piles incorporating steel pipe (casing) and/or steel reinforcement.

PIER FOUNDATIONS. Pier foundations consist of isolated masonry or cast-in-place concrete structural elements extending into firm materials. Piers are relatively short in comparison to their width, with lengths less than or equal to 12 times the least horizontal dimension of the pier. Piers derive their load-carrying capacity through skin friction, through end bearing, or a combination of both.

Belled piers. Belled piers are cast-in-place concrete piers constructed with a base that is larger than the diameter of the remainder of the pier. The belled base is designed to increase the load-bearing area of the pier in end bearing.

PILE FOUNDATIONS. Pile foundations consist of concrete, wood or steel structural elements either driven into the ground or cast in place. Piles are relatively slender in comparison to their length, with lengths exceeding 12 times the least horizontal dimension. Piles derive their load-carrying capacity through skin friction, end bearing or a combination of both.

Augered uncased piles. Augered uncased piles are constructed by depositing concrete into an uncased augered hole, either during or after the withdrawal of the auger.

Caisson piles. Caisson piles are cast-in-place concrete piles extending into bedrock. The upper portion of a caisson pile consists of a cased pile that extends to the bedrock. The lower portion of the caisson pile consists of an uncased socket drilled into the bedrock.

Concrete-filled steel pipe and tube piles. Concrete-filled steel pipe and tube piles are constructed by driving a steel pipe or tube section into the soil and filling the pipe or tube section with concrete. The steel pipe or tube section is left in place during and after the deposition of the concrete.

Driven uncased piles. Driven uncased piles are constructed by driving a steel shell into the soil to shore an unexcavated hole that is later filled with concrete. The steel casing is lifted out of the hole during the deposition of the concrete.

Enlarged base piles. Enlarged base piles are cast-in-place concrete piles constructed with a base that is larger than the diameter of the remainder of the pile. The enlarged base is designed to increase the load-bearing area of the pile in end bearing.

Steel-cased piles. Steel-cased piles are constructed by driving a steel shell into the soil to shore an unexcavated hole. The steel casing is left permanently in place and filled with concrete.

Timber piles. Timber piles are round, tapered timbers with the small (tip) end embedded into the soil.

1808.2 Piers and piles—general requirements.

1808.2.1 Design. Piles are permitted to be designed in accordance with provisions for piers in Section 1808 and Sections 1812.3 through 1812.10 where either of the following conditions exists, subject to the approval of the building official:

1. Group R-3 and U occupancies not exceeding two stories of light-frame construction, or
2. Where the surrounding foundation materials furnish adequate lateral support for the pile.

1808.2.2 General. Pier and pile foundations shall be designed and installed on the basis of a foundation investigation as defined in Section 1802, unless sufficient data upon which to base the design and installation is available.

The investigation and report provisions of Section 1802 shall be expanded to include, but not be limited to, the following:

1. Recommended pier or pile types and installed capacities.
2. Recommended center-to-center spacing of piers or piles.
3. Driving criteria.
4. Installation procedures.
5. Field inspection and reporting procedures (to include procedures for verification of the installed bearing capacity where required).
6. Pier or pile load test requirements.
7. Durability of pier or pile materials.
8. Designation of bearing stratum or strata.
9. Reductions for group action, where necessary.

1808.2.3 Special types of piles. The use of types of piles not specifically mentioned herein is permitted, subject to the approval of the building official, upon the submission of acceptable test data, calculations and other information relating to the structural properties and load capacity of such piles. The allowable stresses shall not in any case exceed the limitations specified herein.

1808.2.4 Pile caps. Pile caps shall be of reinforced concrete, and shall include all elements to which piles are connected, including grade beams and mats. The soil immediately below the pile cap shall not be considered as carrying any vertical load. The tops of piles shall be embedded not less than 3 inches (76 mm) into pile caps and the caps shall extend at least 4 inches (102 mm) beyond the edges of piles. The tops of piles shall be cut back to sound material before capping.

1808.2.5 Stability. Piers or piles shall be braced to provide lateral stability in all directions. Three or more piles connected by a rigid cap shall be considered braced, provided that the piles are located in radial directions from the centroid of the group not less than 60 degrees (1 rad) apart. A two-pile group in a rigid cap shall be considered to be braced along the axis connecting the two piles. Methods used to brace piers or piles shall be subject to the approval of the building official.

Piles supporting walls shall be driven alternately in lines spaced at least 1 foot (305 mm) apart and located symmetrically under the center of gravity of the wall load carried, unless effective measures are taken to provide for eccentricity and lateral forces, or the wall piles are adequately braced to provide for lateral stability. A single row of piles without lateral bracing is permitted for one- and two-family dwellings and lightweight construction not exceeding two stories or 35 feet (10 668 mm) in height, provided the centers of the piles are located within the width of the foundation wall.

1808.2.6 Structural integrity. Piers or piles shall be installed in such a manner and sequence as to prevent distortion or damage that may adversely affect the structural integrity of piles being installed or already in place.

1808.2.7 Splices. Splices shall be constructed so as to provide and maintain true alignment and position of the component parts of the pier or pile during installation and subsequent thereto and shall be of adequate strength to transmit the vertical and lateral loads and moments occurring at the location of the splice during driving and under service loading. Splices shall develop not less than 50 percent of the least capacity of the pier or pile in bending. In addition, splices occurring in the upper 10 feet (3048 mm) of the embedded portion of the pier or pile shall be capable of resisting at allowable working stresses the moment and shear that would result from an assumed eccentricity of the pier or pile load of 3 inches (76 mm), or the pier or pile shall be braced in accordance with Section 1808.2.5 to other piers or piles that do not have splices in the upper 10 feet (3048 mm) of embedment.

1808.2.8 Allowable pier or pile loads.

1808.2.8.1 Determination of allowable loads. The allowable axial and lateral loads on piers or piles shall be determined by an approved formula, load tests or method of analysis.

1808.2.8.2 Driving criteria. The allowable compressive load on any pile where determined by the application of an approved driving formula shall not exceed 40 tons (356 kN). For allowable loads above 40 tons (356 kN), the wave equation method of analysis shall be used to estimate pile driveability of both driving stresses and net displacement per blow at the ultimate load. Allowable loads shall be verified by load tests in accordance with Section 1808.2.8.3. The formula or wave equation load shall be determined for gravity-drop or power-actuated hammers and the hammer energy used shall be the maximum consistent with the size, strength and weight of the driven piles. The use of a follower is permitted only with the approval of the building official. The introduction of fresh hammer cushion or pile cushion material just prior to final penetration is not permitted.

1808.2.8.3 Load tests. Where design compressive loads per pier or pile are greater than those permitted by Section 1808.2.10 or where the design load for any pier or pile foundation is in doubt, control test piers or piles shall be tested in accordance with ASTM D 1143 or ASTM D 4945. At least one pier or pile shall be test loaded in each area of uniform subsoil conditions. Where required by the building official, additional piers or piles shall be load tested where necessary to establish the safe design capacity. The resulting allowable loads shall not be more than one-half of the ultimate axial load capacity of the test pier or pile as assessed by one of the published methods listed in Section 1808.2.8.3.1 with consideration for the test type, duration and subsoil. The ultimate axial load capacity shall be determined by a registered design professional with consideration given to tolerable total and differential settlements at design load in accordance with Section 1808.2.12. In subsequent installation of the balance of foundation piles, all piles shall be deemed to have a supporting capacity equal to the control pile where such piles are of the same type, size and relative length as the test pile; are installed using the same or comparable methods and equipment as the test pile; are installed in similar subsoil conditions as the test pile; and, for driven piles, where the rate of penetration (e.g., net displacement per blow) of such piles is equal to or less than that of the test pile driven with the same hammer through a comparable driving distance.

1808.2.8.3.1 Load test evaluation. It shall be permitted to evaluate pile load tests with any of the following methods:

1. Davisson Offset Limit.
2. Brinch-Hansen 90% Criterion.
3. Butler-Hoy Criterion.
4. Other methods approved by the building official.

1808.2.8.4 Allowable frictional resistance. The assumed frictional resistance developed by any pier or uncased cast-in-place pile shall not exceed one-sixth of the bearing value of the soil material at minimum depth as set forth in Table 1804.2, up to a maximum of 500 psf (24 kPa), unless a greater value is allowed by the building official after a soil investigation, as specified in Section 1802, is submitted or a greater value is substantiated by a load test in accordance with Section 1808.2.8.3. Frictional resistance and bearing resistance shall not be assumed to act simultaneously unless recommended by a soil investigation as specified in Section 1802.

1808.2.8.5 Uplift capacity. Where required by the design, the uplift capacity of a single pier or pile shall be determined by an approved method of analysis based on a minimum factor of safety of three or by load tests conducted in accordance with ASTM D 3689. The maximum allowable uplift load shall not exceed the ultimate load capacity as determined in Section 1808.2.8.3 divided by a factor of safety of two. For pile groups subjected to uplift, the allowable working uplift load for the group shall be the lesser of:

1. The proposed individual pile uplift working load times the number of piles in the group.
2. Two-thirds of the effective weight of the pile group and the soil contained within a block defined by the perimeter of the group and the length of the pile.

1808.2.8.6 Load-bearing capacity. Piers, individual piles and groups of piles shall develop ultimate load capacities of at least twice the design working loads in the designated load-bearing layers. Analysis shall show that no soil layer underlying the designated load-bearing layers causes the load-bearing capacity safety factor to be less than two.

1808.2.8.7 Bent piers or piles. The load-bearing capacity of piers or piles discovered to have a sharp or sweeping bend shall be determined by an approved method of analysis or by load testing a representative pier or pile.

1808.2.8.8 Overloads on piers or piles. The maximum compressive load on any pier or pile due to mislocation shall not exceed 110 percent of the allowable design load.

1808.2.9 Lateral support.

1808.2.9.1 General. Any soil other than fluid soil shall be deemed to afford sufficient lateral support to the pier or pile to prevent buckling and to permit the design of the pier or pile in accordance with accepted engineering practice and the applicable provisions of this code.

1808.2.9.2 Unbraced piles. Piles standing unbraced in air, water or in fluid soils shall be designed as columns in accordance with the provisions of this code. Such piles driven into firm ground can be considered fixed and laterally supported at 5 feet (1524 mm) below the ground surface and in soft material at 10 feet (3048 mm) below the ground surface unless otherwise prescribed by the building official after a foundation investigation by an approved agency.

1808.2.9.3 Allowable lateral load. Where required by the design, the lateral load capacity of a pier, a single pile or a pile group shall be determined by an approved method of analysis or by lateral load tests to at least twice the proposed design working load. The resulting allowable load shall not be more than one-half of that test load that produces a gross lateral movement of 1 inch (25 mm) at the ground surface.

1808.2.10 Use of higher allowable pier or pile stresses. Allowable stresses greater than those specified for piers or for each pile type in Sections 1809 and 1810 are permitted where supporting data justifying such higher stresses is filed with the building official. Such substantiating data shall include:

1. A soils investigation in accordance with Section 1802.
2. Pier or pile load tests in accordance with Section 1808.2.8.3, regardless of the load supported by the pier or pile.

The design and installation of the pier or pile foundation shall be under the direct supervision of a registered design professional knowledgeable in the field of soil mechanics and pier or pile foundations who shall certify to the building official that the piers or piles as installed satisfy the design criteria.

1808.2.11 Piles in subsiding areas. Where piles are installed through subsiding fills or other subsiding strata and derive support from underlying firmer materials, consideration shall be given to the downward frictional forces that may be imposed on the piles by the subsiding upper strata.

Where the influence of subsiding fills is considered as imposing loads on the pile, the allowable stresses specified in this chapter are permitted to be increased where satisfactory substantiating data are submitted.

1808.2.12 Settlement analysis. The settlement of piers, individual piles or groups of piles shall be estimated based on approved methods of analysis. The predicted settlement shall cause neither harmful distortion of, nor instability in, the structure, nor cause any stresses to exceed allowable values.

1808.2.13 Preexcavation. The use of jetting, augering or other methods of preexcavation shall be subject to the approval of the building official. Where permitted, preexcavation shall be carried out in the same manner as used for piers or piles subject to load tests and in such a manner that will not impair the carrying capacity of the piers or piles already in place or damage adjacent structures. Pile tips shall be driven below the preexcavated depth until the required resistance or penetration is obtained.

1808.2.14 Installation sequence. Piles shall be installed in such sequence as to avoid compacting the surrounding soil to the extent that other piles cannot be installed properly, and to prevent ground movements that are capable of damaging adjacent structures.

1808.2.15 Use of vibratory drivers. Vibratory drivers shall only be used to install piles where the pile load capacity is verified by load tests in accordance with Section 1808.2.8.3. The installation of production piles shall be controlled according to power consumption, rate of penetration or other approved means that ensure pile capacities equal or exceed those of the test piles.

1808.2.16 Pile driveability. Pile cross sections shall be of sufficient size and strength to withstand driving stresses without damage to the pile, and to provide sufficient stiffness to transmit the required driving forces.

1808.2.17 Protection of pile materials. Where boring records or site conditions indicate possible deleterious action on pier or pile materials because of soil constituents, changing water levels or other factors, the pier or pile materials shall be adequately protected by materials, methods or processes approved by the building official. Protective materials shall be applied to the piles so as not to be rendered ineffective by driving. The effectiveness of such protective measures for the particular purpose shall have been thoroughly established by satisfactory service records or other evidence.

1808.2.18 Use of existing piers or piles. Piers or piles left in place where a structure has been demolished shall not be used for the support of new construction unless satisfactory evidence is submitted to the building official, which indicates that the piers or piles are sound and meet the requirements of this code. Such piers or piles shall be load tested or redriven to verify their capacities. The design load applied to such piers or piles shall be the lowest allowable load as determined by tests or redriving data.

1808.2.19 Heaved piles. Piles that have heaved during the driving of adjacent piles shall be redriven as necessary to develop the required capacity and penetration, or the capacity of the pile shall be verified by load tests in accordance with Section 1808.2.8.3.

1808.2.20 Identification. Pier or pile materials shall be identified for conformity to the specified grade with this identity maintained continuously from the point of manufacture to the point of installation or shall be tested by an approved agency to determine conformity to the specified grade. The approved agency shall furnish an affidavit of compliance to the building official.

1808.2.21 Pier or pile location plan. A plan showing the location and designation of piers or piles by an identification system shall be filed with the building official prior to installation of such piers or piles. Detailed records for piers or individual piles shall bear an identification corresponding to that shown on the plan.

1808.2.22 Special inspection. Reserved.

1808.2.23 Seismic design of piers or piles. Reserved.

1808.2.23.1 Seismic Design Category C. Reserved.

1803.2.23.1.1 Connection to pile cap. Reserved.

1803.2.23.1.2 Design details. Reserved.

1803.2.23.2 Seismic Design Category D, E, or F. Reserved.

1803.2.23.2.1 Design details for piers, piles, and grade beams. Reserved.

1808.2.23.2.2 Connection to pile cap. Reserved.

1808.2.23.2.3 Flexural strength. Reserved.

SECTION 1809
DRIVEN PILE FOUNDATIONS

1809.1 Timber piles. Timber piles shall be designed in accordance with the AF&PA NDS.

1809.1.1 Materials. Round timber piles shall conform to ASTM D 25. Sawn timber piles shall conform to DOC PS-20.

1809.1.2 Preservative treatment. Timber piles used to support permanent structures shall be treated in accordance with this section unless it is established that the tops of the untreated timber piles will be below the lowest ground-water level assumed to exist during the life of the structure. Preservative and minimum final retention shall be in accordance with AWPA U1 (Commodity Specification E, Use Category 4C) for round timber piles and AWPA U1 (Commodity Specification A, Use Category 4B) for sawn timber piles. Preservative-treated timber piles shall be subject to a quality control program administered by an approved agency. Pile cutoffs shall be treated in accordance with AWPA M4.

1809.1.3 Defective piles. Any substantial sudden increase in rate of penetration of a timber pile shall be investigated for possible damage. If the sudden increase in rate of penetration cannot be correlated to soil strata, the pile shall be removed for inspection or rejected.

1809.1.4 Allowable stresses. The allowable stresses shall be in accordance with the AF&PA NDS.

1809.2 Precast concrete piles.

1809.2.1 General. The materials, reinforcement and installation of precast concrete piles shall conform to Sections 1809.2.1.1 through 1809.2.1.4.

1809.2.1.1 Design and manufacture. Piles shall be designed and manufactured in accordance with accepted engineering practice to resist all stresses induced by handling, driving and service loads.

1809.2.1.2 Minimum dimension. The minimum lateral dimension shall be 8 inches (203 mm). Corners of square piles shall be chamfered.

1809.2.1.3 Reinforcement. Longitudinal steel shall be arranged in a symmetrical pattern and be laterally tied with steel ties or wire spiral spaced not more than 4 inches (102 mm) apart, center to center, for a distance of 2 feet (610 mm) from the ends of the pile; and not more than 6 inches (152 mm) elsewhere except that at the ends of each pile, the first five ties or spirals shall be spaced 1 inch (25 mm) center to center. The gage of ties and spirals shall be as follows:

For piles having a diameter of 16 inches (406 mm) or less, wire shall not be smaller than 0.22 inch (5.6 mm) (No. 5 gage).

For piles having a diameter of more than 16 inches (406 mm) and less than 20 inches (508 mm), wire shall not be smaller than 0.238 inch (6 mm) (No. 4 gage).

For piles having a diameter of 20 inches (508 mm) and larger, wire shall not be smaller than 0.25 inch (6.4 mm) round or 0.259 inch (6.6 mm) (No. 3 gage).

1809.2.1.4 Installation. Piles shall be handled and driven so as not to cause injury or overstressing, which affects durability or strength.

1809.2.2 Precast nonprestressed piles. Precast nonprestressed concrete piles shall conform to Sections 1809.2.2.1 through 1809.2.2.5.

1809.2.2.1 Materials. Concrete shall have a 28-day specified compressive strength (f'_c) of not less than 3,000 psi (20.68 MPa).

1809.2.2.2 Minimum reinforcement. The minimum amount of longitudinal reinforcement shall be 0.8 percent of the concrete section and shall consist of at least four bars.

1809.2.2.2.1 Seismic reinforcement in Seismic Design Category C. Reserved.

1809.2.2.2.2 Seismic reinforcement in Seismic Design Category D, E or F. Reserved.

1809.2.2.3 Allowable stresses. The allowable compressive stress in the concrete shall not exceed 33 percent of the 28-day specified compressive strength (f'_c) applied to the gross cross-sectional area of the pile. The allowable compressive stress in the reinforcing steel shall not exceed 40 percent of the yield strength of the steel (f_y) or a maximum of 30,000 psi (207 MPa). The allowable tensile stress in the reinforcing steel shall not exceed 50 percent of the yield strength of the steel (f_y) or a maximum of 24,000 psi (165 MPa).

1809.2.2.4 Installation. A precast concrete pile shall not be driven before the concrete has attained a compressive strength of at least 75 percent of the 28-day specified compressive strength (f'_c), but not less than the strength sufficient to withstand handling and driving forces.

1809.2.2.5 Concrete cover. Reinforcement for piles that are not manufactured under plant conditions shall have a concrete cover of not less than 2 inches (51 mm).

Reinforcement for piles manufactured under plant control conditions shall have a concrete cover of not less than 1.25 inches (32 mm) for No. 5 bars and smaller, and not less than 1.5 inches (38 mm) for No. 6 through No. 11 bars except that longitudinal bars spaced less than 1.5 inches (38 mm) clear distance apart shall be considered bundled bars for which the minimum concrete cover shall be equal to that for the equivalent diameter of the bundled bars.

Reinforcement for piles exposed to seawater shall have a concrete cover of not less than 3 inches (76 mm).

1809.2.3 Precast prestressed piles. Precast prestressed concrete piles shall conform to the requirements of Sections 1809.2.3.1 through 1809.2.3.5.

1809.2.3.1 Materials. Prestressing steel shall conform to ASTM A 416. Concrete shall have a 28-day specified compressive strength (f'_c) of not less than 5,000 psi (34.48 MPa).

1809.2.3.2 Design. Precast prestressed piles shall be designed to resist stresses induced by handling and driving as well as by loads. The effective prestress in the pile shall not be less than 400 psi (2.76 MPa) for piles up to 30 feet (9144 mm) in length, 550 psi (3.79 MPa) for piles up to 50 feet (15 240 mm) in length and 700 psi (4.83 MPa) for piles greater than 50 feet (15 240 mm) in length.

Effective prestress shall be based on an assumed loss of 30,000 psi (207 MPa) in the prestressing steel. The tensile stress in the prestressing steel shall not exceed the values specified in ACI 318.

1809.2.3.2.1 Design in Seismic Design Category C. Reserved.

1809.2.3.2.2 Design in Seismic Design Category D, E or F. Reserved.

1809.2.3.3 Allowable stresses. The allowable design compressive stress, f_c, in concrete shall be determined as follows:

$$f_c = 0.33f'_c - 0.27f_{pc} \qquad \textbf{(Equation 18-10)}$$

where:

f'_c = The 28-day specified compressive strength of the concrete.

f_{pc} = The effective prestress stress on the gross section.

1809.2.3.4 Installation. A prestressed pile shall not be driven before the concrete has attained a compressive strength of at least 75 percent of the 28-day specified compressive strength (f'_c), but not less than the strength sufficient to withstand handling and driving forces.

1809.2.3.5 Concrete cover. Prestressing steel and pile reinforcement shall have a concrete cover of not less than $1^1/_4$ inches (32 mm) for square piles of 12 inches (305 mm) or smaller size and $1^1/_2$ inches (38 mm) for larger piles, except that for piles exposed to seawater, the minimum protective concrete cover shall not be less than $2^1/_2$ inches (64 mm).

1809.3 Structural steel piles. Structural steel piles shall conform to the requirements of Sections 1809.3.1 through 1809.3.4.

1809.3.1 Materials. Structural steel piles, steel pipe and fully welded steel piles fabricated from plates shall conform to ASTM A 36, ASTM A 252, ASTM A 283, ASTM A 572, ASTM A 588, ASTM A 690, ASTM A 913 or ASTM A 992.

1809.3.2 Allowable stresses. The allowable axial stresses shall not exceed 35 percent of the minimum specified yield strength (F_y).

Exception: Where justified in accordance with Section 1808.2.10, the allowable axial stress is permitted to be increased above $0.35F_y$, but shall not exceed $0.5F_y$.

1809.3.3 Dimensions of H-piles. Sections of H-piles shall comply with the following:

1. The flange projections shall not exceed 14 times the minimum thickness of metal in either the flange or the web and the flange widths shall not be less than 80 percent of the depth of the section.
2. The nominal depth in the direction of the web shall not be less than 8 inches (203 mm).
3. Flanges and web shall have a minimum nominal thickness of $^3/_8$ inch (9.5 mm).

1809.3.4 Dimensions of steel pipe piles. Steel pipe piles driven open ended shall have a nominal outside diameter of not less than 8 inches (203 mm). The pipe shall have a minimum cross section of 0.34 square inch (219 mm^2) to resist each 1,000 foot-pounds (1356 N-m) of pile hammer energy, or shall have the equivalent strength for steels having a yield strength greater than 35,000 psi (241 Mpa) or the wave equation analysis shall be permitted to be used to assess compression stresses induced by driving to evaluate if the pile section is appropriate for the selected hammer. Where pipe wall thickness less than 0.179 inch (4.6 mm) is driven open ended, a suitable cutting shoe shall be provided.

SECTION 1810
CAST-IN-PLACE CONCRETE PILE FOUNDATIONS

1810.1 General. The materials, reinforcement and installation of cast-in-place concrete piles shall conform to Sections 1810.1.1 through 1810.1.3.

1810.1.1 Materials. Concrete shall have a 28-day specified compressive strength (f'_c) of not less than 2,500 psi (17.24 MPa). Where concrete is placed through a funnel hopper at the top of the pile, the concrete mix shall be designed and proportioned so as to produce a cohesive workable mix having a slump of not less than 4 inches (102 mm) and not more than 6 inches (152 mm). Where concrete is to be pumped, the mix design including slump shall be adjusted to produce a pumpable concrete.

1810.1.2 Reinforcement. Except for steel dowels embedded 5 feet (1524 mm) or less in the pile and as provided in Section 1810.3.4, reinforcement where required shall be assembled and tied together and shall be placed in the pile as a unit before the reinforced portion of the pile is filled with concrete except in augered uncased cast-in-place piles. Tied reinforcement in augered uncased cast-in-place piles shall be placed after piles are concreted, while the concrete is still in a semifluid state.

1810.1.2.1 Reinforcement in Seismic Design Category C. Reserved.

1810.1.2.2 Reinforcement in Seismic Design Category D, E or F. Reserved.

1810.1.3 Concrete placement. Concrete shall be placed in such a manner as to ensure the exclusion of any foreign matter and to secure a full-sized shaft. Concrete shall not be placed through water except where a tremie or other approved method is used. When depositing concrete from the top of the pile, the concrete shall not be chuted directly into the pile but shall be poured in a rapid and continuous operation through a funnel hopper centered at the top of the pile.

1810.2 Enlarged base piles. Enlarged base piles shall conform to the requirements of Sections 1810.2.1 through 1810.2.5.

1810.2.1 Materials. The maximum size for coarse aggregate for concrete shall be $^3/_4$ inch (19.1 mm). Concrete to be compacted shall have a zero slump.

1810.2.2 Allowable stresses. The maximum allowable design compressive stress for concrete not placed in a permanent steel casing shall be 25 percent of the 28-day specified compressive strength (f'_c). Where the concrete is place in a permanent steel casing, the maximum allowable concrete stress shall be 33 percent of the 28-day specified compressive strength (f'_c).

1810.2.3 Installation. Enlarged bases formed either by compacting concrete or driving a precast base shall be formed in or driven into granular soils. Piles shall be constructed in the same manner as successful prototype test piles driven for the project. Pile shafts extending through peat or other organic soil shall be encased in a permanent steel casing. Where a cased shaft is used, the shaft shall be adequately reinforced to resist column action or the annular space around the pile shaft shall be filled sufficiently to reestablish lateral support by the soil. Where pile heave occurs, the pile shall be replaced unless it is demonstrated that the pile is undamaged and capable of carrying twice its design load.

1810.2.4 Load-bearing capacity. Pile load-bearing capacity shall be verified by load tests in accordance with Section 1808.2.8.3.

1810.2.5 Concrete cover. The minimum concrete cover shall be $2^1/_2$ inches (64 mm) for uncased shafts and 1 inch (25 mm) for cased shafts.

1810.3 Drilled or augered uncased piles. Drilled or augered uncased piles shall conform to Sections 1810.3.1 through 1810.3.5.

1810.3.1 Allowable stresses. The allowable design stress in the concrete of drilled or augered uncased piles shall not exceed 33 percent of the 28-day specified compressive strength (f'_c). The allowable compressive stress of reinforcement shall not exceed 40 percent of the yield strength of the steel or 25,500 psi (175.8 MPa).

1810.3.2 Dimensions. The pile length shall not exceed 30 times the average diameter. The minimum diameter shall be 12 inches (305 mm).

Exception: The length of the pile is permitted to exceed 30 times the diameter, provided that the design and installation of the pile foundation are under the direct supervision of a registered design professional knowledgeable in the field of soil mechanics and pile foundations. The registered design professional shall certify to the building official that the piles were installed in compliance with the approved construction documents.

1810.3.3 Installation. Where pile shafts are formed through unstable soils and concrete is placed in an open-drilled hole, a steel liner shall be inserted in the hole prior to placing the concrete. Where the steel liner is withdrawn during concreting, the level of concrete shall be maintained above the bottom of the liner at a sufficient height to offset any hydrostatic or lateral soil pressure.

Where concrete is placed by pumping through a hollow-stem auger, the auger shall be permitted to rotate in a clockwise direction during withdrawal. The auger shall be withdrawn in continuous increments. Concreting pumping pressures shall be measured and maintained high enough at all times to offset hydrostatic and lateral earth pressures. Concrete volumes shall be measured to ensure that the volume of concrete placed in each pile is equal to or greater than the theoretical volume of the hole created by the auger. Where the installation process of any pile is interrupted or a loss of concreting pressure occurs, the pile shall be redrilled to 5 feet (1524 mm) below the elevation of the tip of the auger when the installation was interrupted or concrete pressure was lost and reformed. Augered cast-in-place piles shall not be installed within six pile diameters center to center of a pile filled with concrete less than 12 hours old, unless approved by the building official. If the concrete level in any completed pile drops due to installation of an adjacent pile, the pile shall be replaced.

1810.3.4 Reinforcement. For piles installed with a hollow-stem auger where full-length longitudinal steel reinforcement is placed without lateral ties, the reinforcement shall be placed through the hollow stem of the auger prior to filling the pile with concrete. All pile reinforcement shall have a concrete cover of not less than 2.5 inches (64 mm).

Exception: Where physical constraints do not allow the placement of the longitudinal reinforcement prior to filling the pile with concrete or where partial-length longitudinal reinforcement is placed without lateral ties, the reinforcement is allowed to be placed after the piles are completely concreted but while concrete is still in a semi-fluid state.

1810.3.5 Reinforcement in Seismic Design Category C, D, E or F. Reserved.

1810.4 Driven uncased piles. Driven uncased piles shall conform to Sections 1810.4.1 through 1810.4.4.

1810.4.1 Allowable stresses. The allowable design stress in the concrete shall not exceed 25 percent of the 28-day specified compressive strength (f'_c) applied to a cross-sectional area not greater than the inside area of the drive casing or mandrel.

1810.4.2 Dimensions. The pile length shall not exceed 30 times the average diameter. The minimum diameter shall be 12 inches (305 mm).

Exception: The length of the pile is permitted to exceed 30 times the diameter, provided that the design and installation of the pile foundation is under the direct supervision of a registered design professional knowledgeable in the field of soil mechanics and pile foundations. The registered design professional shall certify to the building official that the piles were installed in compliance with the approved design.

1810.4.3 Installation. Piles shall not be driven within six pile diameters center to center in granular soils or within one-half the pile length in cohesive soils of a pile filled with concrete less than 48 hours old unless approved by the building official. If the concrete surface in any completed pile rises or drops, the pile shall be replaced. Piles shall not be installed in soils that could cause pile heave.

1810.4.4 Concrete cover. Pile reinforcement shall have a concrete cover of not less than 2.5 inches (64 mm), measured from the inside face of the drive casing or mandrel.

1810.5 Steel-cased piles. Steel-cased piles shall comply with the requirements of Sections 1810.5.1 through 1810.5.4.

1810.5.1 Materials. Pile shells or casings shall be of steel and shall be sufficiently strong to resist collapse and sufficiently water tight to exclude any foreign materials during the placing of concrete. Steel shells shall have a sealed tip with a diameter of not less than 8 inches (203 mm).

1810.5.2 Allowable stresses. The allowable design compressive stress in the concrete shall not exceed 33 percent of the 28-day specified compressive strength (f'_c). The allowable concrete compressive stress shall be 0.40 (f'_c) for that portion of the pile meeting the conditions specified in Sections 1810.5.2.1 through 1810.5.2.4.

1810.5.2.1 Shell thickness. The thickness of the steel shell shall not be less than manufacturer's standard gage No. 14 gage (0.068 inch) (1.75 mm) minimum.

1810.5.2.2 Shell type. The shell shall be seamless or provided with seams of strength equal to the basic material and be of a configuration that will provide confinement to the cast-in-place concrete.

1810.5.2.3 Strength. The ratio of steel yield strength (f_y) to 28-day specified compressive strength (f'_c) shall not be less than six.

1810.5.2.4 Diameter. The nominal pile diameter shall not be greater than 16 inches (406 mm).

1810.5.3 Installation. Steel shells shall be mandrel driven their full length in contact with the surrounding soil.

The steel shells shall be driven in such order and with such spacing as to ensure against distortion of or injury to piles already in place. A pile shall not be driven within four and one-half average pile diameters of a pile filled with concrete less than 24 hours old unless approved by the building official. Concrete shall not be placed in steel shells within heave range of driving.

1810.5.4 Reinforcement. Reinforcement shall not be placed within 1 inch (25 mm) of the steel shell. Reinforcing shall be required for unsupported pile lengths or where the pile is designed to resist uplift or unbalanced lateral loads.

1810.5.4.1 Seismic reinforcement. Reserved.

1810.6 Concrete-filled steel pipe and tube piles. Concrete-filled steel pipe and tube piles shall conform to the requirements of Sections 1810.6.1 through 1810.6.5.

1810.6.1 Materials. Steel pipe and tube sections used for piles shall conform to ASTM A 252 or ASTM A 283. Concrete shall conform to Section 1810.1.1. The maximum coarse aggregate size shall be $^3/_4$ inch (19.1 mm).

1810.6.2 Allowable stresses. The allowable design compressive stress in the concrete shall not exceed 33 percent of the 28-day specified compressive strength (f'_c). The allowable design compressive stress in the steel shall not exceed 35 percent of the minimum specified yield strength of the steel (F_y), provided F_y shall not be assumed greater than 36,000 psi (248 MPa) for computational purposes.

Exception: Where justified in accordance with Section 1808.2.10, the allowable stresses are permitted to be increased to 0.50 F_y.

1810.6.3 Minimum dimensions. Piles shall have a nominal outside diameter of not less than 8 inches (203 mm) and a minimum wall thickness in accordance with Section 1809.3.4. For mandrel-driven pipe piles, the minimum wall thickness shall be $^1/_{10}$ inch (2.5 mm).

1810.6.4 Reinforcement. Reinforcement steel shall conform to Section 1810.1.2. Reinforcement shall not be placed within 1 inch (25 mm) of the steel casing.

1810.6.4.1 Seismic reinforcement. Reserved.

1810.6.5 Placing concrete. The placement of concrete shall conform to Section 1810.1.3, but is permitted to be chuted directly into smooth-sided pipes and tubes without a centering funnel hopper.

1810.7 Caisson piles. Caisson piles shall conform to the requirements of Sections 1810.7.1 through 1810.7.6.

1810.7.1 Construction. Caisson piles shall consist of a shaft section of concrete-filled pipe extending to bedrock with an uncased socket drilled into the bedrock and filled with concrete. The caisson pile shall have a full-length structural steel core or a stub core installed in the rock socket and extending into the pipe portion a distance equal to the socket depth.

1810.7.2 Materials. Pipe and steel cores shall conform to the material requirements in Section 1809.3. Pipes shall have a minimum wall thickness of $^3/_8$ inch (9.5 mm) and shall be fitted with a suitable steel-driving shoe welded to the bottom of the pipe. Concrete shall have a 28-day specified compressive strength (f'_c) of not less than 4,000 psi (27.58 MPa). The concrete mix shall be designed and proportioned so as to produce a cohesive workable mix with a slump of 4 inches to 6 inches (102 mm to 152 mm).

1810.7.3 Design. The depth of the rock socket shall be sufficient to develop the full load-bearing capacity of the caisson pile with a minimum safety factor of two, but the depth shall not be less than the outside diameter of the pipe. The design of the rock socket is permitted to be predicated on the sum of the allowable load-bearing pressure on the bottom of the socket plus bond along the sides of the socket. The minimum outside diameter of the caisson pile shall be 18 inches (457 mm), and the diameter of the rock socket shall be approximately equal to the inside diameter of the pile.

1810.7.4 Structural core. The gross cross-sectional area of the structural steel core shall not exceed 25 percent of the gross area of the caisson. The minimum clearance between the structural core and the pipe shall be 2 inches (51 mm). Where cores are to be spliced, the ends shall be milled or ground to provide full contact and shall be full-depth welded.

1810.7.5 Allowable stresses. The allowable design compressive stresses shall not exceed the following: concrete, 0.33 f'_c; steel pipe, 0.35 F_y and structural steel core, 0.50 F_y.

1810.7.6 Installation. The rock socket and pile shall be thoroughly cleaned of foreign materials before filling with concrete. Steel cores shall be bedded in cement grout at the base of the rock socket. Concrete shall not be placed through water except where a tremie or other approved method is used.

1810.8 Micropiles. Micropiles shall conform to the requirements of Sections 1810.8.1 through 1810.8.5.

1810.8.1 Construction. Micropiles shall consist of a grouted section reinforced with steel pipe or steel reinforcing. Micropiles shall develop their load-carrying capacity through a bond zone in soil, bedrock or a combination of soil and bedrock. The full length of the micropile shall contain either a steel pipe or steel reinforcement.

1810.8.2 Materials. Grout shall have a 28-day specified compressive strength (f'_c) of not less than 4,000 psi (27.58 MPa). The grout mix shall be designed and proportioned so as to produce a pumpable mixture. Reinforcement steel shall be deformed bars in accordance with ASTM A 615 Grade 60 or 75 or ASTM A 722 Grade 150.

Pipe/casing shall have a minimum wall thickness of $^3/_{16}$ inch (4.8 mm) and as required to meet Section 1808.2.7. Pipe/casing shall meet the tensile requirements of ASTM A 252 Grade 3, except the minimum yield strength shall be as used in the design submittal [typically 50,000 psi to 80,000 psi (345 MPa to 552 MPa)] and minimum elongation shall be 15 percent.

1810.8.3 Allowable stresses. The allowable design compressive stress on grout shall not exceed 0.33 f'_c. The allowable design compressive stress on steel pipe and steel reinforcement shall not exceed the lesser of 0.4 F_y, or 32,000 psi (220 MPa). The allowable design tensile stress for steel reinforcement shall not exceed 0.60 F_y. The allowable design tensile stress for the cement grout shall be zero.

1810.8.4 Reinforcement. For piles or portions of piles grouted inside a temporary or permanent casing or inside a hole drilled into bedrock or a hole drilled with grout, the steel pipe or steel reinforcement shall be designed to carry at least 40 percent of the design compression load. Piles or portions of piles grouted in an open hole in soil without temporary or permanent casing and without suitable means of verifying the hole diameter during grouting shall be designed to carry the entire compression load in the reinforcing steel. Where a steel pipe is used for reinforcement, the portion of the cement grout enclosed within the pipe is permitted to be included at the allowable stress of the grout.

1810.8.4.1 Seismic reinforcement. Reserved.

1810.8.5 Installation. The pile shall be permitted to be formed in a hole advanced by rotary or percussive drilling methods, with or without casing. The pile shall be grouted with a fluid cement grout. The grout shall be pumped through a tremie pipe extending to the bottom of the pile until grout of suitable quality returns at the top of the pile. The following requirements apply to specific installation methods:

1. For piles grouted inside a temporary casing, the reinforcing steel shall be inserted prior to withdrawal of the casing. The casing shall be withdrawn in a controlled manner with the grout level maintained at the top of the pile to ensure that the grout completely fills the drill hole. During withdrawal of the casing, the grout level inside the casing shall be monitored to check that the flow of grout inside the casing is not obstructed.
2. For a pile or portion of a pile grouted in an open drill hole in soil without temporary casing, the minimum design diameter of the drill hole shall be verified by a suitable device during grouting.
3. For piles designed for end bearing, a suitable means shall be employed to verify that the bearing surface is properly cleaned prior to grouting.
4. Subsequent piles shall not be drilled near piles that have been grouted until the grout has had sufficient time to harden.
5. Piles shall be grouted as soon as possible after drilling is completed.
6. For piles designed with casing full length, the casing must be pulled back to the top of the bond zone and reinserted or some other suitable means shall be employed to verify grout coverage outside the casing.

SECTION 1811
COMPOSITE PILES

1811.1 General. Composite piles shall conform to the requirements of Sections 1811.2 through 1811.5.

1811.2 Design. Composite piles consisting of two or more approved pile types shall be designed to meet the conditions of installation.

1811.3 Limitation of load. The maximum allowable load shall be limited by the capacity of the weakest section incorporated in the pile.

1811.4 Splices. Splices between concrete and steel or wood sections shall be designed to prevent separation both before and after the concrete portion has set, and to ensure the alignment and transmission of the total pile load. Splices shall be designed to resist uplift caused by upheaval during driving of adjacent piles, and shall develop the full compressive strength and not less than 50 percent of the tension and bending strength of the weaker section.

1811.5 Seismic reinforcement. Reserved.

SECTION 1812
PIER FOUNDATIONS

1812.1 General. Isolated and multiple piers used as foundations shall conform to the requirements of Sections 1812.2 through 1812.10, as well as the applicable provisions of Section 1808.2.

1812.2 Lateral dimensions and height. The minimum dimension of isolated piers used as foundations shall be 2 feet (610 mm), and the height shall not exceed 12 times the least horizontal dimension.

1812.3 Materials. Concrete shall have a 28-day specified compressive strength (f'_c) of not less than 2,500 psi (17.24 MPa). Where concrete is placed through a funnel hopper at the top of the pier, the concrete mix shall be designed and proportioned so as to produce a cohesive workable mix having a slump of not less than 4 inches (102 mm) and not more than 6 inches (152 mm). Where concrete is to be pumped, the mix design including slump shall be adjusted to produce a pumpable concrete.

1812.4 Reinforcement. Except for steel dowels embedded 5 feet (1524 mm) or less in the pier, reinforcement where required shall be assembled and tied together and shall be placed in the pier hole as a unit before the reinforced portion of the pier is filled with concrete.

Exception: Reinforcement is permitted to be wet set and the $2^1/_2$- inch (64 mm) concrete cover requirement be reduced to 2 inches (51 mm) for Group R-3 and U occupancies not exceeding two stories of light-frame construction, provided the construction method can be demonstrated to the satisfaction of the building official.

Reinforcement shall conform to the requirements of Sections 1810.1.2.1 and 1810.1.2.2.

Exceptions:

1. Isolated piers supporting posts of Group R-3 and U occupancies not exceeding two stories of light-frame

construction are permitted to be reinforced as required by rational analysis but not less than a minimum of one No. 4 bar, without ties or spirals, when detailed so the pier is not subject to lateral loads and the soil is determined to be of adequate stiffness.

2. Isolated piers supporting posts and bracing from decks and patios appurtenant to Group R-3 and U occupancies not exceeding two stories of light-frame construction are permitted to be reinforced as required by rational analysis but not less than one No. 4 bar, without ties or spirals, when the soil is determined to be of adequate stiffness.
3. Piers supporting the concrete foundation wall of Group R-3 and U occupancies not exceeding two stories of light-frame construction are permitted to be reinforced as required by rational analysis but not less than two No. 4 bars, without ties or spirals, when the soil is determined to be of adequate stiffness.
4. Reserved.

1812.5 Concrete placement. Concrete shall be placed in such a manner as to ensure the exclusion of any foreign matter and to secure a full-sized shaft. Concrete shall not be placed through water except where a tremie or other approved method is used. When depositing concrete from the top of the pier, the concrete shall not be chuted directly into the pier but shall be poured in a rapid and continuous operation through a funnel hopper centered at the top of the pier.

1812.6 Belled bottoms. Where pier foundations are belled at the bottom, the edge thickness of the bell shall not be less than that required for the edge of footings. Where the sides of the bell slope at an angle less than 60 degrees (1 rad) from the horizontal, the effects of vertical shear shall be considered.

1812.7 Masonry. Where the unsupported height of foundation piers exceeds six times the least dimension, the allowable working stress on piers of unit masonry shall be reduced in accordance with ACI 530/ASCE 5/TMS 402.

1812.8 Concrete. Where adequate lateral support is not provided, and the unsupported height to least lateral dimension does not exceed three, piers of plain concrete shall be designed and constructed as pilasters in accordance with ACI 318. Where the unsupported height to least lateral dimension exceeds three, piers shall be constructed of reinforced concrete, and shall conform to the requirements for columns in ACI 318.

Exception: Where adequate lateral support is furnished by the surrounding materials as defined in Section 1808.2.9, piers are permitted to be constructed of plain or reinforced concrete. The requirements of ACI 318 for bearing on concrete shall apply.

1812.9 Steel shell. Where concrete piers are entirely encased with a circular steel shell, and the area of the shell steel is considered reinforcing steel, the steel shall be protected under the conditions specified in Section 1808.2.17. Horizontal joints in the shell shall be spliced to comply with Section 1808.2.7.

1812.10 Dewatering. Where piers are carried to depths below water level, the piers shall be constructed by a method that will provide accurate preparation and inspection of the bottom, and the depositing or construction of sound concrete or other masonry in the dry.

SECTIONS 1813 – 1815
RESERVED

SECTION 1816
TERMITE PROTECTION

1816.1 Termite protection. Termite protection shall be provided by registered termiticides, including soil-applied pesticides, baiting systems and pesticides applied to wood, or other approved methods of termite protection labeled for use as a preventative treatment to new construction. See Section 202, Registered Termiticide. Upon completion of the application of the termite protective treatment, a certificate of compliance shall be issued to the building department by the licensed pest control company that contains the following statement: "The building has received a complete treatment for the prevention of subterranean termites. Treatment is in accordance with rules and laws established by the Florida Department of Agriculture and Consumer Services."

1816.1.1 If soil treatment is used for subterranean termite prevention, the initial chemical soil treatment inside the foundation perimeter shall be done after all excavation, backfilling and compaction is complete.

1816.1.2 If soil treatment is used for subterranean termite prevention, soil area disturbed after initial chemical soil treatment shall be retreated with a chemical soil treatment, including spaces boxed or formed.

1816.1.3 If soil treatment is used for subterranean termite prevention, space in concrete floors boxed out or formed for the subsequent installation of plumbing traps, drains or any other purpose shall be created by using plastic or metal permanently placed forms of sufficient depth to eliminate any planned soil disturbance after initial chemical soil treatment.

1816.1.4 If soil treatment is used for subterranean termite prevention, chemically treated soil shall be protected with a minimum 6 millimeter vapor retarder to protect against rainfall dilution. If rainfall occurs before vapor retarder placement, retreatment is required. Any work, including placement of reinforcing steel, done after chemical treatment until the concrete floor is poured, shall be done in such manner as to avoid penetrating or disturbing treated soil.

1816.1.5 If soil treatment is used for subterranean termite prevention, concrete overpour or mortar accumulated along the exterior foundation perimeter shall be removed prior to exterior chemical soil treatment to enhance vertical penetration of the chemicals.

1816.1.6 If soil treatment is used for subterranean termite prevention, chemical soil treatments shall also be applied under all exterior concrete or grade within 1 foot (305 mm) of the primary structure sidewalls. Also, a vertical chemical barrier shall be applied promptly after construction is completed, including initial landscaping and irrigation/sprinkler installation. Any soil disturbed after the chemical vertical barrier is applied shall be promptly retreated.

1816.1.7 If a registered termiticide formulated and registered as a bait system is used for subterranean termite prevention, Sections 1816.1.1 through 1816.1.6 do not apply; however, a signed contract assuring the installation, maintenance and monitoring of the baiting system for a minimum of 5 years from the issue of the certificate of occupancy shall be provided to the building official prior to the pouring of the slab, and the system must be installed prior to final building approval. If the baiting system directions for use require a monitoring phase prior to installation of the pesticide active ingredient, the installation of the monitoring phase components shall be deemed to constitute installation of the system.

1816.1.8 If a registered termiticide formulated and registered as a wood treatment is used for subterranean termite prevention, Sections 1816.1.1 through 1816.1.6 do not apply. Application of the wood-treatment termiticide shall be as required by label directions for use, and must be completed prior to final building approval. Changes in framing or additions to framing in areas of the structure requiring treatment that occur after the initial wood treatment must be treated prior to final building approval.

1816.2 Penetration.

1816.2.1 Protective sleeves around metallic piping penetrating concrete slab-on-grade floors shall not be of cellulose-containing materials.

1816.2.2 If soil treatment is used for subterranean termite protection, the protective sleeve shall meet the following minimum requirements:

1. The sleeve shall have a nominal thickness of 0.025 inch.
2. The sleeve shall be sized for the pipe.
3. The sleeve shall be sealed within the slab using a noncorrosive mechanical clamping device to eliminate the annular space between the pipe and pipe sleeve.

SECTION 1817
HIGH-VELOCITY HURRICANE ZONES – EXCAVATIONS

1817.1 General. Until provisions for permanent support have been made, all excavations shall be properly guarded and protected so as to prevent them from becoming dangerous to life and property and shall be sheet piled, braced and/or shored, where necessary, to prevent the adjoining earth from caving in; such protection to be provided by the person causing the excavation to be made. All excavations shall comply with the minimum requirements of Section 553.60, *Florida Statute* "Trench Safety Act," and 29 CFR 1926-650 (P) "Occupational Safety and Health Administration Excavation Safety Act." No excavation, for any purpose, shall extend within 1 foot (305 mm) of the angle of repose of any soil bearing footing or foundation unless such footing or foundation is first properly underpinned or protected against settlement.

1817.2 Permanent excavations. No permanent excavation shall be made nor shall any construction excavations be left on any lot that will endanger adjoining property or buildings or be a menace to public health or safety. Any such excavations made or maintained shall be properly drained and such drainage provisions shall function properly as long as the excavation exists. Permanent excavations shall have retaining walls of steel, masonry, concrete or similar approved material of sufficient strength to retain the embankment together with any surcharged loads.

1817.3 Enforcement. Where, in the opinion of the building official, an unsafe condition may result or damage may occur as the result of an excavation, he or she may order the work stopped or may approve the work of excavation subject to such limitations, as he or she may deem necessary.

SECTION 1818
HIGH-VELOCITY HURRICANE ZONES— BEARING CAPACITY OF SOIL

1818.1 Design bearing capacity. Plans for new buildings, structures or additions shall clearly identify the nature of the soil under the structure and the allowable bearing capacity used in sizing the building foundation support system.

Exception: See Section1822.1 for plans for new buildings, structures or additions that are to be supported on a piling foundation system.

1818.2 Allowable bearing capacity. Prior to the installation of any footing foundation system for new buildings, structures or additions, the building official shall be provided with a statement of allowable bearing capacity from an architect or professional engineer. Said statement shall clearly identify the allowable in-place bearing capacity of the building pad for the new building or addition and verify the existing soil conditions. The certified in-place bearing capacity shall have been determined using recognized tests or rational analysis and shall meet or exceed the design bearing capacity identified under Section 1818.1.

SECTION 1819
HIGH-VELOCITY HURRICANE ZONES— SOIL BEARING FOUNDATIONS

1819.1 General. Footings shall be constructed of reinforced concrete, as set forth in Chapter 19 (High-Velocity Hurricane Zones) of this code and in this section, and shall, insofar as is practicable, be so designed that the soil pressure shall be reasonably uniform to minimize differential settlement.

1819.2 Continuous wall footings.

1819.2.1 Footings under walls shall be continuous or continuity otherwise provided and shall be not less than required to keep the soil pressure within that set forth in Section1818 nor less than the following minimums:

Allowable bearing capacity pounds per square foot	No. of Stories	Minimum Depth and Width [2] (inches)
2000	1	12 × 16[1]
2000	2	12 × 24

For SI: 1 inch = 25.4 mm; 1 pound per square foot 47.89 Pa.

Based on rational analysis and soil investigation as set forth in section Section 1818, the footing size or bearing capacity may vary, but the minimum width of a footing under the main walls of the building shall not be less than 16 inches nor less than 8 inches more than the width of the wall.

NOTES:

1. For single-story wood frame exterior walls, the minimum size continuous footing shall be 16 inches deep × 24 inches wide.
2. Any continuous wall footing acting as a shear wall foundation shall be specifically designed for that purpose.

1819.2.2 Masonry fences, flower bins, steps and similar decorative structures shall have reinforced concrete foundations designed for all live, dead and wind loads as set forth in Chapter 16 (High-Velocity Hurricane Zones) of this code. The minimum size of these foundations shall be as follows:

Allowable bearing capacity (pounds per square foot)	Unbraced Wall Above Grade (ft)	Minimum Depth and Width[2] (inches)
2,000	Less than or equal to 3 feet	12 x 16
2,000	Greater than 3 feet but less than and including 6 feet	12 x 36
2,000	Greater than 6 feet	None Provided[1]

For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 pound per square foot = 47.88 kPa.

NOTES:

1. Foundations for masonry fences, flower bins, steps and similar decorative structures with unbraced heights in excess of six feet shall be based on rational analysis.
2. The minimum continuous footings specified in this section shall be reinforced in accordance with Section 1819.3.

1819.2.3 Based on rational analysis and soil investigation as set forth in Section1818, the footing size or bearing capacity may vary, but the minimum width of a footing under masonry fences, flower bins, steps and similar decorative structures shall not be less than16 inches (406 mm) nor less than 8 inches (203 mm) more than the width of the wall.

Exception: Masonry fences, wing walls and other similar walls that are exposed to lateral wind forces and do not have any lateral restraint above grade, shall have their continuous wall footings placed so the top of footing is no less than 16 inches (406 mm) below grade.

1819.3 The minimum continuous footings specified in this section shall be reinforced as follows:

Reinforcing	Foundation Width
2 # 5	16" and 20" wide
3 # 5	24" and 30" wide
4 # 5	36" wide

1819.3.1 Where footings are 30 inches (762 mm) or more in width, cross bars designed to resist bending at the face of the foundation wall shall be provided.

1819.3.1.1 Equivalent areas in #4 reinforcing bars may be substituted for the sizes as specified in Section 1819.3.

1819.3.1.2 Splices in reinforcing bars shall be not less than 36 bar diameters and reinforcement shall be continuous around all corners and changes in direction. Continuity shall be provided at corners or changes in direction by bending the longitudinal steel around the corner 48 bar diameters or by adding matching reinforcing steel, which shall extend 48 bar diameters from each corner or change in direction When three or more bars are required, the bars shall be held in place and aligned by transverse bars spaced not more than 4 feet (1219 mm) apart.

1819.3.1.3 The reinforcement for footings and other principal structural members in which concrete is deposited against the ground shall have not less than 3 inches (76 mm) of concrete between the reinforcement and the ground contact surface. If concrete surfaces after removal of the forms are to be exposed to the weather or be in contact with the ground, the reinforcement shall be protected with not less than 2 inches (51 mm) of concrete for bars larger than #5 and $1^1/_2$ (38 mm) for #5 or smaller bars.

1819.3.1.4 Excavations for continuous footings shall be cut true to line and grade and the sides of footings shall be formed, except where soil conditions are such that the sides of the excavation stand firm and square. Excavations shall be made to firm, clean bearing soil.

1819.4 Continuous footings shall be placed level and any changes in the grade of such footings shall be made with a vertical tie of the same cross section and design as the footings, or the smaller of the footings, so joined.

1819.4.1 Continuous footings with eccentric loading shall be designed to limit the soil pressure at the edges to within acceptable values by means of counterbalancing or by other approved methods.

1819.4.2 When foundation walls are to be poured separately from the footing, they shall be keyed and doweled to the footing with no less than #4 dowels, 20 diameters in length above and below the joint, spaced not more than 4 feet (1219 mm) apart. Where footing depth does not allow straight dowels, standard hooks will be allowable.

1819.4.3 Concrete footing and pads shall not receive superimposed loads until 12 hours or more after the concrete is placed.

1819.4.4 Excavations for footings and foundations, which are to serve as forms, shall be thoroughly wetted prior to the placement of concrete.

1819.4.5 The top of all continuous footings shall be a minimum of 8 inches (203 mm) below grade.

1819.5 Isolated footings. Dimensions for an isolated footing shall not be less than 12 inches (305 mm) deep and 24 inches square (.02 m^2). Isolated footings in soil having low lateral restraint and isolated piers shall be provided with adequate bracing to resist lateral movement.

1819.5.1 Isolated footings with eccentric loading shall be designed to limit the soil pressure at the edges by means of footing straps or other approved methods.

1819.5.2 When isolated footings support reinforced concrete columns, dowels equivalent in number and area to the column reinforcement and having a length not less than 36 diameters above and below the joint shall be provided in the footing. Where the footing depth precludes straight dowels, standard ACI hooks will be allowable. Such dowels, or anchor bolts as required for steel columns, shall be held to proper grade and location during the pouring of the footing by means of templates or by other approved methods.

1819.5.3 The top of all isolated footings shall be a minimum of 8 inches (203 mm) below grade.

1819.5.4 Any isolated footing subjected to uplift and/or overturning forces shall be specifically designed for that purpose, as set forth in Section 1620.

1819.6 Lateral sliding resistance. The resistance of structural walls to lateral sliding shall be calculated by combining the values derived from the lateral bearing and the lateral sliding resistance shown in Table 1819.6 unless data to substantiate the use of higher values are submitted for approval. For clay, sandy clay and clayey silt, in no case shall the lateral sliding resistance exceed one-half the dead load.

1819.6.1 Increases in allowable lateral sliding resistance. The resistance values derived from the table may be increased by the tabular value for each additional foot of depth to a maximum of 15 times the tabular value. Isolated poles for uses such as flagpoles or signs and poles used to support buildings which are not adversely affected by 1/2-inch (12.7 mm) motion at the ground surface because of short-term lateral loads may be designed using lateral bearing values equal to two times the tabular values.

1819.7 Designs employing lateral bearing. Designs to resist lateral loads employing posts or poles as columns embedded in earth or embedded in concrete footings in the earth shall conform to the requirements of Sections 1819.7.1 through 1819.7.2.1.

1819.7.1 Limitation. Posts embedded in earth shall not be used to provide lateral support for structural or non structural materials such as plaster, masonry or concrete unless bracing is provided that develops the limited deflection required.

1819.7.2 Design criteria. The depth to resist lateral loads shall be determined by the design criteria in Sections1819.7.2.1 through 1819.7.2.2 or by other methods approved by the building official.

1819.7.2.1 Unconstrained. The following formula shall be used in determining the depth of embedment required to resist the lateral loads where no constraint is provided at the ground surface, such as a structural diaphragm.

$$d = 0.5A\{1 + [1 + (4.36h/A)]1/2\}$$

Where:

$A = 2.34P/(S_1 b)$

b = diameter of round post or diagonal dimension of square post or footing, feet.

d = depth of embedment in earth in feet but not over 12 feet (3658 mm) for purpose of computing lateral pressure.

h = distance in feet from ground surface to point of application of P.

P = applied lateral force, pounds.

S_1 = Allowable lateral soil-bearing pressure as set forth in Table 1819.6 based on a depth of one-third the depth of embedment, pounds per square foot.

S_3 = Allowable lateral soil-bearing pressure as set forth in Table 1819.6 based on a depth equal to the depth of embedment, pounds per square foot.

1819.7.2.2 Constrained. The following formula shall be used in determining the depth of embedment required to resist the lateral loads where constraint is provided at the ground surface, such as a rigid floor or rigid ground surface pavement.

$$d^2 = 4.25(Ph/ S_3 b)$$

or alternately

$$d^2 = 4.25(M_g/ S_3 b)$$

Where:

M_g = Moment in the post at grade, foot-pounds.

TABLE 1819.6
ALLOWABLE LATERAL PRESSURE

CLASS OF MATERIALS	LATERAL BEARING (psf/ft BELOW NATURAL GRADE)	LATERAL SLIDING	
		Coefficient of Friction (a)	Resistance (psf)(b)
1. Sedimentary and foliated rock	400	0.35	
2. Sandy gravel and/or gravel	200	0.35	
3. Sand, silty sand, clayey sand, silty gravel land clayey gravel	150	0.25	
4. Clay, sandy clay, silty clay, clayey silt, silt and sandy silt	100		130

For SI: 1 pound per square foot = 47.88 Pa.

NOTES:

a. Coefficient to be multiplied by the dead load.

b. Lateral sliding resistance to be multiplied by the contact area, as limited by Section 1819.6.

SECTION 1820
HIGH-VELOCITY HURRICANE ZONES—
CONCRETE SLABS ON FILL

1820.1 Concrete floors placed directly on the supporting soil shall comply with this section.

1820.2 Where it is proposed to place concrete slabs directly on the supporting soil, a subgrade shall be thoroughly compacted by approved methods. All fill placed under slabs shall be clean sand or rock, free of debris and other deleterious materials. The maximum size of rock within 12 inches (305 mm) below the floor slab in compacted fill shall be 3 inches (76 mm) in diameter. Where fill material includes rock, large rocks shall not be allowed to nest and all voids shall be carefully filled with small stones or sand, and properly compacted.

1820.3. Concrete floor slabs placed directly on the supporting soil shall be a minimum of 4 inches (102 mm) in thickness, reinforced with not less than 0.028 square inches (18 mm2) of reinforcing per linear foot of slab in each direction.

1820.3.1 Fill supporting such slabs shall be compacted under the supervision of a special inspector to a minimum of 95 percent of maximum dry density for all layers, as verified by field density tests specified in Section1820.3.2.

1820.3.2 Tests shall be made in accordance with Methods of Test for Moisture Density Relations of Soils, ASTM D 1557 modified to use 25 blows on five layers with a 10-pound (5 kg) hammer dropping 18 inches (457 mm). In addition, a minimum of one in-place field density test shall be performed for each 2,500 square feet (232 m2), or fraction thereof, for each lift of compacted soil, and such testing shall be performed in accordance with either ASTM D 1556, Standard Test Method for Density of Soil In-Place by the Sandcone; or ASTM D 2922, Standard Test Methods for Density of Soil and Soil Aggregate in-place by Nuclear Methods (Shallow Depth), or other approved methods.

1820.3.3 Where a concrete slab is supported by a foundation wall or continuous footing, the effect of the support shall be considered in the design.

1820.3.4 All concrete slab edges and concrete beams supporting exterior walls shall be recessed a minimum of $^3/_4$ inch (19 mm) below top of slab for a width of the exterior wall, or provided with an alternate water-stop method approved by the building official.

1820.3.5 The discontinuous edges of all slabs surrounding swimming pools and floor slabs for screen patios and utility sheds shall be at least a minimum of 8 inches (203 mm) deep and 8 inches (203 mm) wide and shall be reinforced with one continuous #5 bar.

1820.3.6 Reinforced concrete slabs on fill for garbage containers shall be a minimum of 1 foot (305 mm) larger on all sides than the garbage receptacle (dumpster) and a minimum thickness of 6 inches (152 mm).

1820.4 When polyethylene sheets are used as a vapor barrier beneath a ground floor slab, the subgrade for that slab shall be considered a formed surface for the purpose of reinforcing steel coverage.

1820.5 Concrete slabs outside of buildings, other than patios and pool slabs, where placed directly on the supporting soil, for minor accessory uses such as, but not limited to, walkways, driveways, minor equipment pads, etc, shall be not less than 4 inches (102 mm) thick. Such slabs shall be placed on clean, thoroughly compacted sand or crushed rock free from organics, debris or other deleterious materials.

SECTION 1821
HIGH-VELOCITY HURRICANE ZONES—
MONOLITHIC FOOTINGS

1821.1 Monolithic footings under walls shall be continuous or continuity otherwise provided and shall be not less than required to keep the soil pressure within that set forth in Section 1818 nor less than the following minimums:

Allowable bearing capacity (Pounds per square foot)	No. of Stories	Minimum Depth and Width(2) (inches)
2000	1	12 x 16(1)
2000	2	12 x 24

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 47.88 Pa.

Based on rational analysis and soil investigation as set forth in Section 1818, the footing size or bearing capacity may vary, but the minimum width of a footing under the main walls of the buildings shall not be less than 16 inches nor less than 8 inches more than the width of the foundation wall.

NOTES:

(1) For single story wood frame exterior walls, the minimum size continuous footing shall be 16 inches deep x 24 inches wide.

(2) Any continuous wall footing acting as a shear wall foundation shall be specifically designed for that purpose.

1821.1.1 A minimum outside finish grade of 8 inches (203 mm) above the bottom of the exterior monolithic footing shall be required, but in no case shall the outside finish grade be above the top of the finish slab surface unless sufficient means to minimize moisture intrusion into the structure have been provided to the satisfaction of the building official.

1821.1.2 Continuous monolithic footings shall be placed level and any change in the grade of such footings shall be made with a step of the same cross section and design as the monolithic footings, or the smaller of the monolithic footings, so joined.

1821.1.3 Continuous monolithic footings with eccentric loading shall be designed to limit the soil pressure at the edges to within acceptable values by means of counterbalancing or by other approved methods.

1821.1.4 Concrete monolithic footings and pads shall not receive superimposed loads until 12 hours or more after the concrete is placed.

1821.1.5 Excavations for monolithic footings and foundations, which are to serve as forms, shall be thoroughly wet prior to placing concrete.

1821.1.6 Monolithic foundation systems shall be limited for the support of a maximum of two stories and/or floors or a maximum mean roof height of 25 feet (7620 mm) above grade unless the monolithic foundation system has been designed by a professional engineer and ample consideration has been given to the eccentric loading, foundation rotation and shear cracking at the slab/foundation interface.

1821.1.7 The minimum continuous monolithic footings specified in this section shall be reinforced as follows:

Reinforcing	Minimum Width Foundation (in.)
2 # 5	16" and 20" wide
3 # 5	24" and 30" wide
4 # 5	36" wide

For SI: 1 inch = 25.4 mm.

1821.1.8 Where footings are 30 inches (762 mm) or more in width, cross bars designed to resist bending at the face of the foundation wall shall be provided.

1821.1.9 Equivalent areas in #4 reinforcing bars may be substituted for the sizes as specified in Section 1821.1.7.

1821.1.10 Splices in reinforcing bars shall be not less than 36 bar diameters and reinforcement shall be continuous around all corners and changes in direction. Continuity shall be provided at corners or changes in direction by bending the longitudinal steel around the corner 48 bar diameters or by adding matching reinforcing steel, which shall extend 48 bar diameters from each corner or change in direction. When three or more bars are required, the bars shall be held in place and alignment by transverse bars spaced not more than 4 feet (1219 mm) apart.

1821.1.11 The reinforcement for monolithic footings and other principal structural members in which concrete is deposited against the ground shall have not less than 3 inches (76 mm) of concrete between the reinforcement and the ground contact surface. If concrete surfaces after removal of the forms are to be exposed to the weather or be in contact with the ground, the reinforcement shall be protected with not less than 2 inches (51 mm) of concrete for bars larger than #5 and $1^1/_2$ inches (38 mm) for #5 or smaller bars.

1821.1.12 Excavations for continuous monolithic footings shall be cut true to line and grade and the sides of footings shall be formed, except where soil conditions are such that the sides of the excavation stand firm and square. Excavations shall be made to firm, clean bearing soil.

1821.1.13 Unless otherwise determined by rational analysis, monolithic footings shall have transfer reinforcement along the perimeter of the foundation. Said reinforcement shall be no less than #4 reinforcing steel bars spaced no greater than 12 inches (305 mm) on center and shall be no less than 5 feet (1524 mm) in length plus a standard ACI hook and shall be placed to transfer into the slab section commencing at a point no less than 3 inches (76 mm) from the edge form.

SECTION 1822
HIGH-VELOCITY HURRICANE ZONES— PILE FOUNDATIONS

1822.1 Pile foundations shall be designed and installed on the basis of a geotechnical exploration which shall include field and/or laboratory tests.

1822.1.1 Piles used for the support of any building or structure shall be driven to a resistance and penetration in accordance with the plans and/or specifications as set forth herein.

1822.1.2 Piles may be jetted under the supervision of a professional engineer. Immediately after completion of jetting, piles shall be driven below the depth jetted to the required resistance, but not less than 1 foot (305 mm), or to nominal refusal whichever comes first. No jetting will be permitted that may be detrimental to existing adjacent structures or piles that have been driven.

1822.1.3 When isolated columns, piers and other loads are supported on piles, a minimum of three piles shall be used for such support unless lateral bracing is provided at the pile cap to insure stability. Should a pile group be loaded eccentrically so as to produce an overload on any pile more than 10 percent of the allowable load, footing straps or other approved methods shall be required to counteract the effect of eccentric loading.

1822.1.4 The minimum center-to-center spacing of piles shall be not less than twice the average diameter of round piles or $1^3/_4$ times the diagonal dimensions of rectangular piles but in no case less than 30 inches (762 mm). Piles supporting structural walls shall have dowels installed to offer sufficient resistance for lateral restraint of a grade beam.

1822.1.5 Nonfluid soil shall be considered as providing full lateral support against column action. The portion of a pile that extends through air, water, fluid soil or other unstable material shall be designed as a structural column. Soils having a consistency stiffer than fluid soil may be considered as capable of providing lateral support. Where cast-in-place piles are used reinforcement shall extend 10 feet (3048 mm) below the plane where the soil provides lateral restraint. Sufficient reinforcement for all types of piles shall be provided at the junction of the pile and pile cap or grade beam to make a suitable connection. Shells conforming to Section 1826.1 may be considered as reinforcement.

1822.1.6 Reinforced concrete caps shall be provided for all pile clusters and such caps shall extend laterally not less than 6 inches (152 mm) beyond the extreme pile surface and vertically not less than 4 inches (102 mm) below the pile butt. Pile caps may be omitted when piles are used to support grade beams, provided that the spacing of Section 1822.1.4 is complied with, and provided that the portions of the grade beams acting in place of the pile cap shall be computed by a recognized method of analysis to properly carry the loads.

1822.1.7 Piles shall be driven using an approved cushion block consisting of material arranged to provide transmission of hammer energy equivalent to one-piece hardwood with the grain parallel to the axis of the pile and enclosed in a metal housing to prevent its lateral deformation between the hammer ram and the top of the pile.

1822.1.8 Friction piles shall be driven to a minimum penetration of 12 feet (3658 mm) below the cutoff or the existing ground, whichever is the lower.

1822.1.9 Diesel hammers may be used for driving piles if provided with one of the following means of determining the energy of the hammer's blow.

1822.1.10 Closed-top diesel hammers shall be used with a rating instrument and charts to measure the equivalent WH energy per blow of the hammer. The equivalent WH energy as measured by the instrument shall be the ram's weight times the equivalent ram plus an added value obtained from the energy stored in the bounce chamber. The energy per blow shall be the equivalent WH energy for the closed-top diesel.

1822.1.11 Open-top diesel hammers shall be equipped with a ram stroke indictor rod that is striped in increments above the hammer body and fastened to the body of the hammer. The energy per blow for the open top diesel shall be computed as the ram's working stroke times the ram's weight.

1822.1.12 The load-bearing formula applicable for single-acting pile hammers shall be used to compute the bearing capacity of the driven pile.

1822.1.13 Followers shall be used only upon permission of the special inspector or engineer and only where necessary to effect installation of piles. A follower shall be of a size, shape, length, material and weight to permit driving the pile in the desired location and to the required depth and resistance without loss of hammer energy in the follower.

1822.1.14 Splices shall be avoided as far as practicable. Splices shall be constructed to provide and maintain true alignment and position of the component parts of the pile during installation and subsequent thereto. Splices shall develop the required strength of the pile.

1822.1.15 The safe capacity of a group of friction piles in plastic material may be determined by load testing the group to 150 percent of the proposed group load or by the formula given in Section 1822.2. When computed by formula, the allowable load for such a group shall be the allowable load for one pile times the number of piles in the group times the efficiency of the pile group determined as follows:

$$E = 1 - 0\,\frac{(N-1)M + (M-1)N}{90MN}$$

Where:

E = is the efficiency

S = the average spacing of the piles, inches

M = the number of rows

N = the number of piles in one row

D = the average diameter of the pile, inches

O = arc tan D/S, in degrees

1822.1.16 Types of piles that are not provided for in this section shall conform to the requirements herein for the type that it most nearly approximates, subject to such additional requirements as may be made by the building official.

1822.1.17 Pile driving hammers shall develop a minimum of 1 foot-pound of energy per pound of pile or mandrel, but not less than 7,000 foot-pounds of energy per blow.

1822.1.18 Piles may be driven with drop or gravity hammers provided the hammer shall weigh not less than 3,000 pounds (1362 kg) and the fall of the hammer shall not exceed 6 feet (1829 mm).

1822.1.19 Piles shall be driven with a variation of not more than $^1/_4$ (6 mm) inch per foot from the vertical, or from the batter line indicted, with a maximum variation of the head of the pile from the position shown on the plans of not more than 3 inches (76 mm), subject to the provisions of Section 1822.1.3.

1822.1.20 The special inspector or engineer supervising the pile driving operations shall be required to keep an accurate record of the material and the principal dimensions of each pile; of the weight and fall of the hammer, if a single-acting hammer or drop hammer; the size and make, operating pressure, length of hose, number of blows per minute and energy per blow, if a double-acting hammer; together with the average penetration of each pile for at least the last five blows, and the grades at tip and cut-off. A copy of these records shall be filed with the building official and kept with the plans.

1822.1.21 Where piling must penetrate strata offering high resistance to driving or where jetting could cause damage, the inspector or supervising engineer may require that the piles be set in predrilled or punched holes. The equipment used for drilling or punching must be approved by the special inspector or engineer, and provided that all piles shall reach their final penetration by driving.

1822.1.22 The maximum load permitted on any driven pile shall not exceed 36 tons unless substantiated by a load test performed at the site, as set forth in Section 1829.

1822.1.23 The building official may require tests on any pile where performance is questionable.

1822.1.24 Piles shall be designed and driven to develop not less than 10 tons safe bearing capacity.

1822.1.25 In soils in which the installation of piles causes previously installed piles to heave, accurate level marks shall be put on all piles immediately after installation and all heaved piles shall be reinstalled to the required resistance.

1822.1.26 Piles shall not be driven closer than 2 feet (610 mm) nor jetted closer than 10 feet (3048 mm) to an existing building or structure unless approved by a special inspector or engineer.

1822.2 Driving formula load. Subject to pile load limitations contained in Sections 1823.1.8 and 1824.1.2 and in the absence of pile load test data satisfactory to the building official, the load on a pile shall not exceed that computed from the following driving formula:

Drop Hammer: $$P = \frac{2Wh}{S+1}$$

Single Acting Hammers: $$P = \frac{2Wh}{S+0.1}$$

Double Acting Hammers: $P = \dfrac{2(W + Ap)^h}{S + 0.1}$

Or differential in which:

A = area of piston, square inches

p = pressure at the hammer, pounds per square inch

P = allowable total load, pounds

W= weight of striking part of hammer, pounds

H=height of fall of striking part of hammer, feet, or stroke, feet

S = average penetration per blow of not less than the five final blows

SECTION 1823
HIGH-VELOCITY HURRICANE ZONES—WOOD PILES

1823.1 Woodpiles shall conform to ASTM D 25, Round Timber Piles.

1823.1.1 Untreated wood piles in all cases shall be cut off not higher than mean low water table and shall be capped with concrete.

1823.1.2 Timber piles used to support permanent structures shall be treated in accordance with this section unless it is established that the top of the untreated timber piles will be below lowest ground water level assumed to exist during the life of the structure.

1823.1.3 Preservative and minimum final retention shall be in accordance with AWPA C3.

1823.1.4 When timber piles are used in salt water, the treatment shall conform to AWPA MP-1, MP-2 or MP-4. Pile cutoffs shall be treated in accordance with AWPA M-4.

1823.1.4.1 All preservative-treated wood piles shall have a metal tag, brand or other preservative treatment identification mark.

1823.1.4.2 Such mark shall identify the producer, and/or the appropriate inspection agency, and treatment specifications or quality mark.

1823.1.5 Wood piles which support a structure over water may project above the water to such height as may be necessary for structural purposes, provided that such piles used to support structures other than open wharves, boat landings, and other similar light structures shall have been treated in accordance with Section 1823.1.2

1823.1.6 Wood piles shall be driven with a protective driving cap or ring when necessary to prevent brooming or splitting of the butt. When brooming or splitting occurs, such piles shall be cut back to solid wood before the final resistance to penetrations is measured.

1823.1.7 If required, when driving through or to hard material or to rock, wood piles shall be fitted with a metal protective driving cap shown satisfactory to the building official.

1823.1.8 The maximum allowable load on a round timber pile shall be determined in accordance with Section 1822.1.22, provided the maximum allowable stresses of timber are not exceeded.

1823.1.8.1 The allowable stresses for timber piles shall not exceed the values in Table 1823 except as modified by Part 6 of the National Design Specification for Wood Construction.

SECTION 1824
HIGH-VELOCITY HURRICANE ZONES—PRECAST CONCRETE PILES

1824.1 Precast concrete piles shall be cast of concrete having a compressive strength of not less than 3,000 pounds per square inch (psi) (21 MPa) at the time of driving, and shall be reinforced with a minimum of four longitudinal steel bars having an area of not less than 1 percent nor more than 4 percent of the gross concrete area. All longitudinal bars shall be of uniform size and shall be tied by not less than #2 hoops spaced 8 inches (203 mm) in the body of the pile and not over 3 inches (76 mm) for the first 18 inches (437 mm) from both the butt and the tip.

TABLE 1823

SPECIES	COMPRESSION PARALLEL TO GRADE (psi)[4]	BENDING (psi)[4]	SHEAR HORIZ (psi)[4]	COMP PERP TO GRAIN (psi)[4]	MODULUS OF ELASTICITY
Pacific Coast Douglas Fir[1]	1,250	2,450	115	230	1,500,000
Southern Pine[2]	1,200	2,400	110	250	1,500,000
Red Oak[3]	1,100	2,450	135	350	1,250,000
Red Pine[4]	900	1,900	85	155	1,280,000

For SI: 1 pound per square inch = 0.0068 MPa.

1. Pacific Douglas Coast Fir values apply only to species as defined in ASTM Designation 01760-76, Standard Specification for Pressure Treatment of Timber Products. For faster design, use Douglas Fir-Larch design values.
2. Southern Pine values apply to Longleaf, Slash, Loblolly and Short Leaf Pines.
3. Red Oak values apply to Northern and Southern Red Oak.
4. Red Pine values apply to Red Pine grown in the United States.

All reinforcement shall be protected by 2 inches (51 mm) or more of concrete, except that for piles subjected to the action of open water, waves or other severe exposure, a 3-inch (76 mm) protective covering shall be furnished in the zone of such exposure. For point bearing piles, the concrete area of the tip shall be not less than 75 percent of the area of the butt.

1824.1.1 All precast concrete piles shall have their date of manufacture and the lifting points clearly marked on the pile. Concrete piles shall not be driven until they have attained their full specification strength as verified by tests, nor shall the piles be removed from the forms until 50 percent of the specification strength has been attained. Piles shall not be transported nor driven until they have been cured not less than seven days for Type I cement and three days for Type III cement.

1824.1.2 In the absence of load tests, the maximum allowable load per pile shall not exceed the values set forth in Table 1824.

TABLE 1824

SIZE (INCHES)	MAXIMUM LOAD (TONS)
10 x 10	17
12 x 12	25
14 x 14	35

For SI: 1 inch = 25.4 mm.

SECTION 1825 HIGH-VELOCITY HURRICANE ZONES — PRESTRESSED PRECAST CONCRETE PILES

1825.1 Prestressed precast concrete piles shall conform to Chapter 19 (High-Velocity Hurricane Zones) and to Sections 1822.1.1, 1822.2, 1824 and 1828 except as specifically detailed in this section.

1825.1.1 Prestressed concrete piles shall be cast of concrete having a compressive strength of not less than 5,000 psi (34 MPa) at time of driving and 3,000 psi (21 MPa) before transfer of the prestressing force. The prestressing elements shall not be stressed initially in excess of 75 percent of ultimate strength. The elements shall transfer a compressive stress to the concrete, after losses, of not less than 0.08 percent of the specified strength at driving. Under loads other than handling no tension will be permitted in the concrete.

1825.1.2 Longitudinal reinforcing shall be protected by 2 inches (51 mm) of concrete and shall be tied by #2 hoops or #5 AS&W gauge spirals spaced at 8 inches (203 mm) in the body of piling 14 inches (356 mm) or smaller or 9 inches (22 mm) in the body of piling 16 inches (76 mm) or larger and not over 3 inches (76 mm) for the first 18 inches (457 mm) from both the butt and the tip.

SECTION 1826 HIGH-VELOCITY HURRICANE ZONES— CAST-IN-PLACE

1826.1 Cast-in place concrete piles shall consist of a steel shell driven in intimate contact with the surrounding soil and left in place and filled with concrete. Steel shells may be uniformly tapered, step-tapered, cylindrical or a combination of such shapes and may be laterally corrugated, spirally corrugated, longitudinally fluted or plain.

1826.1.1 Pile shells and end closures shall be of sufficient strength and rigidity to permit their driving in keeping with the driving method used, and to prevent harmful distortion caused by soil pressures or the driving of adjacent piles until filled with concrete. A reduction of cross sectional area in excess of 15 percent shall be cause for rejection. The shells shall also be sufficiently water tight to exclude water during the placing of concrete.

1826.1.2 The minimum diameter shall be 8 inches.

1826.1.3 Concrete for cast-in-place piles shall develop a compressive strength of not less than 3,000 psi (21 MPa) in 28 days. The concrete shall be deposited in a continuous operation to insure a full-sized pile without voids or separation. Concrete shall be placed in the dry. The pile may be sealed by depositing concrete by tremie or other approved method.

1826.1.4 Splices of shell sections shall be designed to insure the alignment of the shells and develop the full strength of the shell station.

1826.1.5 The load on the shell shall not exceed 25 percent of the minimum average tensile yield strength of the steel multiplied by the area of the shell.

1826.1.5.1 Shells having a wall thickness of 0.119 inch (3 mm) or more may be considered as carrying part of the load.

1826.1.5.2 Adequate allowance for corrosion shall be considered in the design but not less than the outer inch of the shell thickness shall be deducted before computing the area of the shell considered as carrying load.

1826.1.5.3 The metal for the shells shall conform to the Standards of Welded and Seamless Steel Pipe Piles, Grade 2, ASTM A 252, for Hot-Rolled Carbon Steel Sheets and Strip of Structural Quality, ASTM A 570 and Carbon Structural Steel, Cold-Rolled Sheet, ASTM A 611.

1826.1.5.4 The yield strength used in design shall be that of the material in the fabricated shell.

1826.1.6 For friction piles, the allowable load shall be computed at the cross section located at a point two-thirds of the embedded length of the pile, in material providing suitable lateral support, measured upward from the tip. The load on the concrete shall not exceed 25 percent of the 28-day strength of the concrete multiplied by the concrete area.

1826.1.7 For end-bearing piles, the concrete area of the critical section shall be such that the unit stress on the concrete does not exceed 0.25 $f'c$ under the pile load. The area of the shell and the critical section of the concrete shall be taken at the elevation where the pile enters the stratum furnishing and bearing.

SECTION 1827 HIGH-VELOCITY HURRICANE ZONES — ROLLED STRUCTURAL SHAPES

1827.1 Rolled structural steel piles shall conform to the Standards for general requirements for Hot-Rolled and Cold-Finished Carbon and Alloy Steel Bars, ASTM A 29, and Carbon Steel Bars Subject to Mechanical Property Requirements, ASTM A 306, except that copper may be added to increase the corrosion-resistant properties of the material.

1827.1.1 Sections of such pile of H form shall have flange projections not exceeding 14 times the thickness of web or flange and total flange width not less than 85 percent of the depth of the section.

1827.1.2 No section shall have a nominal thickness of metal less than $^{3}/_{8}$ inch (10 mm).

1827.1.3 For end-bearing piles, the allowable stress may be determined on the basis of an allowable stress of 25 percent of the yield value of the steel.

1827.1.4 In the absence of adequate corrosion protection, $^{1}/_{16}$ inch (1.6 mm) shall be deducted from each face in determining the area of the pile section.

1827.1.5 The allowable load, when used as friction piles, shall be determined by load tests at the site.

SECTION 1828 HIGH-VELOCITY HURRICANE ZONES — SPECIAL PILES OR SPECIAL CONDITIONS

1828.1 The use of types of piles or conditions not specifically covered herein may be permitted, subject to the approval of the building official, upon submission of acceptable test data, calculations or other information relating to the properties and load-carrying capacity of such piles.

SECTION 1829 HIGH-VELOCITY HURRICANE ZONES— LOAD TESTS ON PILES

1829.1 Single piles tested shall be loaded to at least twice the desired design load and should pile groups be tested, the test load shall be not less than $1^{1}/_{2}$ times the total desired load for the group.

1829.1.1 The apparatus for applying known vertical loads to the top of the pile shall maintain constant load under increasing settlement, and shall apply the loads in such a way that no lateral forces or impact will occur. Hydraulic jacks when used shall be equipped with a calibrated pressure gauge. Uplift piles used to provide the jacking resistance shall be a sufficient distance from the test pile so as not to influence its behavior under test.

1829.1.2 The test load shall be applied in increments of not more than 25 percent of the design load until the total test load has been applied.

1829.1.3 The method for determining vertical movement shall be subject to the approval of the building official. Readings shall be sufficient in number to define the time settlement and rebound curve.

1829.1.4 Each load increment shall be maintained for a minimum of 1 hour, and until the rate of settlement is less than 0.01 inch (.25 mm) per hour. The total load shall be maintained until settlement does not exceed 0.01 (.25 mm) inch in 24 hours. Settlement readings shall be taken at regular intervals during the test period.

1829.1.5 After the maximum load has remained on the pile for 24 hours and final settlement readings have been taken, the pile shall be unloaded in 50-percent decrements of design load. Rebound readings shall be taken at regular intervals during the unloading period, and final reading taken approximately 12 hours after the entire load has been removed.

1829.1.6 The maximum allowable pile load shall be one-half of that load which causes a net settlement of not more than 0.005 inch (.13 mm) per ton of test load, a gross settlement of 1 inch (25 mm) (whichever is less) or a disproportionate increase in settlement.

1829.1.7 Control test piles shall be tested in accordance with ASTM D 1143, Method of Testing Piles Under Axial Compressive Load. If quick load test procedures are used, the applied test load shall be not less than three times the working pile capacity and in accordance with the standard.

SECTION 1830 HIGH-VELOCITY HURRICANE ZONES — FOUNDATION WALLS AND GRADE BEAMS

1830.1 Exterior foundation walls of buildings, where the character of the soil is such that allowable soil loads of 1,500 pounds per square foot (psf) (81 kN/m^2) or less are used for design, shall be poured-in-place reinforced concrete from the footing to the bottom of the first or ground floor construction.

1830.1.1 Exterior foundation walls of building, where the character of the soil is such that allowable soil loads of more than 1,500 psf (71 kN/m^2) are used for design, may be of unit masonry or concrete on continuous concrete footings.

1830.1.2 Under the exterior walls of buildings of Type V construction, in locations where extreme dampness exists, the building official may approve isolated piers, provided such piers are as otherwise set forth in Section 1823.1.1.

1830.2 Detailed requirements.

1830.2.1 The thickness of the foundation wall shall be not less than 8 inches (203 mm).

1830.2.2 Where wood joist construction is used for the first or ground floor, the thickness of the exterior foundation walls shall be not less than 8 inches (203 mm), plus 4 inches (102 mm) for the bearing of joists.

1830.2.3 Foundations of unit masonry supporting joists shall be capped with 4 inches (102 mm) of concrete.

1830.3 Interior bearing walls. Interior foundation walls shall be of the material and design as specified in Section1830.1 except as follows.

1830.3.1 Interior foundation walls that support stud walls shall be exempted from the additional 4 inches (102 mm) of width required for the bearing of joists.

1830.3.2 The use of isolated piers, girders and beams may be substituted for interior foundation walls when designed by a registered architect and/or engineer.

1830.4 Grade beams.

1830.4.1 Grade beams supporting loads between piles or piers shall be reinforced concrete or structural steel protected by 2 inches (51 mm) of concrete cover.

1830.4.2 Grade beams shall be the thickness of the wall they support but never less than 8 inches (203 mm) nor less than set forth for foundation walls herein.

1830.4.3 Grade beams shall be suitably designed and reinforced around access openings and vents.

SECTION 1831 HIGH-VELOCITY HURRICANE ZONES — GRADES UNDER BUILDINGS

1831.1 The grade of the ground under buildings of joist or suspended slab construction having no basements shall not be lower than the lowest surrounding finished lot area grade in order to prevent the accumulation and standing of ground, storm or tide water under such buildings unless provided with other approved means of drainage.

1831.1.1 Plans for future raising of lots shall be taken into account in planning the grade of the ground under such buildings.

1831.1.2 The building official may establish grades under such buildings based on present or future street or sidewalk grades abutting the property.

SECTION 1832 HIGH-VELOCITY HURRICANE ZONES— RETAINING WALLS

1832.1 All walls exceeding 24 inches (610 mm) in height built to retain or support earth, or subject to pressure from adjoining earth, and any surcharge shall be designed to resist the pressure to which they are subjected, including water pressure that may exist.

SECTION 1833 HIGH-VELOCITY HURRICANE ZONES— SEAWALLS AND BULKHEADS

1833.1 All dredging, filling, excavation and waterfront construction such as docks, piers, wharves, bridges, groins, jetties, moles, breakwaters, seawalls, revetments, causeways, artificial nourishment of beaches or other deposition or removal of material in all water areas within the area of jurisdiction of this code shall be planned and designed by a professional engineer, except as noted in Section1833.2, in accordance with this code and the applicable standards and requirements of the administrative authority.

1833.2 The requirement for professional design will not be required by the building official for bulkheads, docks, piers and similar structures constructed in conjunction with private residences on lakes, private canals and similar water frontage not subject to wind, wave or tidal action; do not involve unusual soil conditions, slopes or unstable soil and are not part of a foundation or support for an above-grade structure.

SECTION 1834 HIGH-VELOCITY HURRICANE ZONES— SOIL IMPROVEMENT

1834.1 The application of soil improvement techniques shall comply with this section.

1834.1.1 Methods of soil improvement for a specific site shall be determined by a registered professional engineer, hereinafter referred to as the geotechnical engineer, and such methods shall provide for field testing as required herein.

1834.1.2 A permit shall be required prior to the commencement of any soil improvement, and no building permit shall be issued until it has been determined that adequate bearing capacity has been obtained for the foundation, and the requirements of this section have been satisfied.

1834.2 Limits on application.

1834.2.1 Soil improvement shall not be permitted where subsurface conditions consist of zones of organic materials of sufficient quality above or below the ground water table which cannot be dispersed or displaced to levels not exceeding 5-percent dry weight of organic content in any undisturbed sample.

1834.2.2 Dynamic compaction, vibrocompaction, preloading, surcharging or other similar methods of soil improvements shall not be permitted near or within coastal areas subject to storm surge, scour or other forms of water erosion without suitable protection provided for the building foundation.

1834.3 Required testing.

1834.3.1 A rational program of field tests and soil analyses shall be part of the soil improvement treatment.

1834.3.2 Such tests shall determine the soil characteristics after treatment, and the results of the tests shall demonstrate whether the subsurface improvement has increased the bearing capacity of the soil to that which is capable of safely supporting the proposed construction.

1834.3.3 The testing shall be performed in accordance with the provisions of ASTM D 1586, Standard Penetration Test; ASTM D 3441, Static Cone Soundings; or by Menard Pressuremeter; Dilatometer or other on-site tests recognized by the industry.

1834.3.4 The test results shall be used to determine the achieved bearing capacity and the anticipated settlement.

1834.4 Requirements for acceptance. The efficacy of any application of soil improvement techniques shall be verified by appropriate calculations, testing and documentation as required in this section.

1834.4.1 All organics, including any organic lens, shall be displaced by the injection of sand or other suitable fill material, or otherwise dispersed in accordance with the provisions of this section, to levels not exceeding 5 percent by weight of organic content in any undisturbed sample.

1834.4.2 Complete documentation of required tests shall be required, and shall included as a minimum, but shall not be limited to:

1. A description of the stratigraphy and densification required and
2. Foundation bearing capacity and settlement analysis performed by an independent testing laboratory.
3. The anticipated settlement potential under superimposed loads shall be acknowledged and accepted by the engineer of record in writing prior to issuance of a building permit.
4. The results of testing to determine subsurface conditions shall be retained by the geotechnical engineer and submitted to the building official upon request.

CHAPTER 19
CONCRETE

Italics are used for text within Sections 1903 through 1908 of this code to indicate provisions that differ from ACI 318.

SECTION 1901 GENERAL

1901.1 Scope. The provisions of this chapter shall govern the materials, quality control, design and construction of concrete used in structures.

> **Exception**: Buildings and structures located within the high-velocity hurricane zone shall comply with the provisions of Sections 1917 and 1919 through 1929.

1901.2 Plain and reinforced concrete. Structural concrete shall be designed and constructed in accordance with the requirements of this chapter and ACI 318 as amended in Section 1908 of this code. Except for the provisions of Sections 1904 and 1910, the design and construction of slabs on grade shall not be governed by this chapter unless they transmit vertical loads or lateral forces from other parts of the structure to the soil.

1901.3 Source and applicability. The format and subject matter of Sections 1902 through 1907 of this chapter are patterned after, and in general conformity with, the provisions for structural concrete in ACI 318.

1901.4 Construction documents. The construction documents for structural concrete construction shall include:

1. The specified compressive strength of concrete at the stated ages or stages of construction for which each concrete element is designed.
2. The specified strength or grade of reinforcement.
3. The size and location of structural elements, reinforcement, and anchors.
4. Provision for dimensional changes resulting from creep, shrinkage and temperature.
5. The magnitude and location of prestressing forces.
6. Anchorage length of reinforcement and location and length of lap splices.
7. Type and location of mechanical and welded splices of reinforcement.
8. Details and location of contraction or isolation joints specified for plain concrete.
9. Minimum concrete compressive strength at time of posttensioning.
10. Stressing sequence for posttensioning tendons.
11. Reserved.

1901.5 Special inspection. Reserved.

SECTION 1902 DEFINITIONS

1902.1 General. The words and terms defined in ACI 318 shall, for the purposes of this chapter and as used elsewhere in this code for concrete construction, have the meanings shown in ACI 318.

SECTION 1903 SPECIFICATIONS FOR TESTS AND MATERIALS

1903.1 General. Materials used to produce concrete, concrete itself and testing thereof shall comply with the applicable standards listed in ACI 318. *Where required, special inspections and tests shall be in accordance with Chapter 17.*

1903.2 Glass fiber reinforced concrete. *Glass fiber reinforced concrete (GFRC) and the materials used in such concrete shall be in accordance with the PCI MNL 128 standard.*

SECTION 1904 DURABILITY REQUIREMENTS

1904.1 Water-cementitious materials ratio. Where maximum water-cementitious materials ratios are specified in ACI 318, they shall be calculated in accordance with ACI 318, Section 4.1.

1904.2 Freezing and thawing exposures. Concrete that will be exposed to freezing and thawing, deicing chemicals or other exposure conditions as defined below shall comply with Sections 1904.2.1 through 1904.2.3.

1904.2.1 Air entrainment. Concrete exposed to freezing and thawing or deicing chemicals shall be air entrained in accordance with ACI 318, Section 4.2.1:

1904.2.2 Concrete properties. Concrete that will be subject to the following exposures shall conform to the corresponding maximum water-cementitious materials ratios and minimum specified concrete compressive strength requirements of ACI 318, Section 4.2.2:

1. Concrete intended to have low permeability where exposed to water;
2. Concrete exposed to freezing and thawing in a moist condition or deicer chemicals; or
3. Concrete with reinforcement where the concrete is exposed to chlorides from deicing chemicals, salt, salt water, brackish water, seawater or spray from these sources.

> **Exception:** *For occupancies and appurtenances thereto in Group R occupancies that are in buildings less than four stories in height, normal-weight aggregate concrete shall comply with the require-*

ments of Table 1904.2.2 based on the weathering classification (freezing and thawing) determined from Figure 1904.2.2.

In addition, concrete exposed to deicing chemicals shall conform to the limitations of Section 1904.2.3.

1904.2.3 Deicing chemicals. For concrete exposed to deicing chemicals, the maximum weight of fly ash, other pozzolans, silica fume or slag that is included in the concrete shall not exceed the percentages of the total weight of cementitious materials permitted by ACI 318, Section 4.2.3.

TABLE 1904.2.2
MINIMUM SPECIFIED COMPRESSIVE STRENGTH (f'_c)

TYPE OR LOCATION OF CONCRETE CONSTRUCTION	MINIMUM SPECIFIED COMPRESSIVE STRENGTH (f'_c at 28 days, psi)		
	Negligible exposure	Moderate exposure	Severe exposure
Basement walls[c] and foundations not exposed to the weather	2,500	2,500	2,500[a]
Basement slabs and interior slabs on grade, except garage floor slabs	2,500	2,500	2,500[a]
Basement walls[c], foundation walls, exterior walls and other vertical concrete surfaces exposed to the weather	2,500	3,000[b]	3,000[b]
Driveways, curbs, walks, patios, porches, carport slabs, steps and other flatwork exposed to the weather, and garage floor slabs	2,500	3,000[b, d]	3,500[b, d]

For SI: 1 pound per square inch = 0.00689 MPa.

a. Concrete in these locations that can be subjected to freezing and thawing during construction shall be of air-entrained concrete in accordance with Section 1904.2.1.

b. Concrete shall be air entrained in accordance with Section 1904.2.1.

c. Structural plain concrete basement walls are exempt from the requirements for exposure conditions of Section 1904.2.2 (see Section 1909.6.1).

d. For garage floor slabs where a steel trowel finish is used, the total air content required by Section 1904.2.1 is permitted to be reduced to not less than 3 percent, provided the minimum specified compressive strength of the concrete is increased to 4,000 psi.

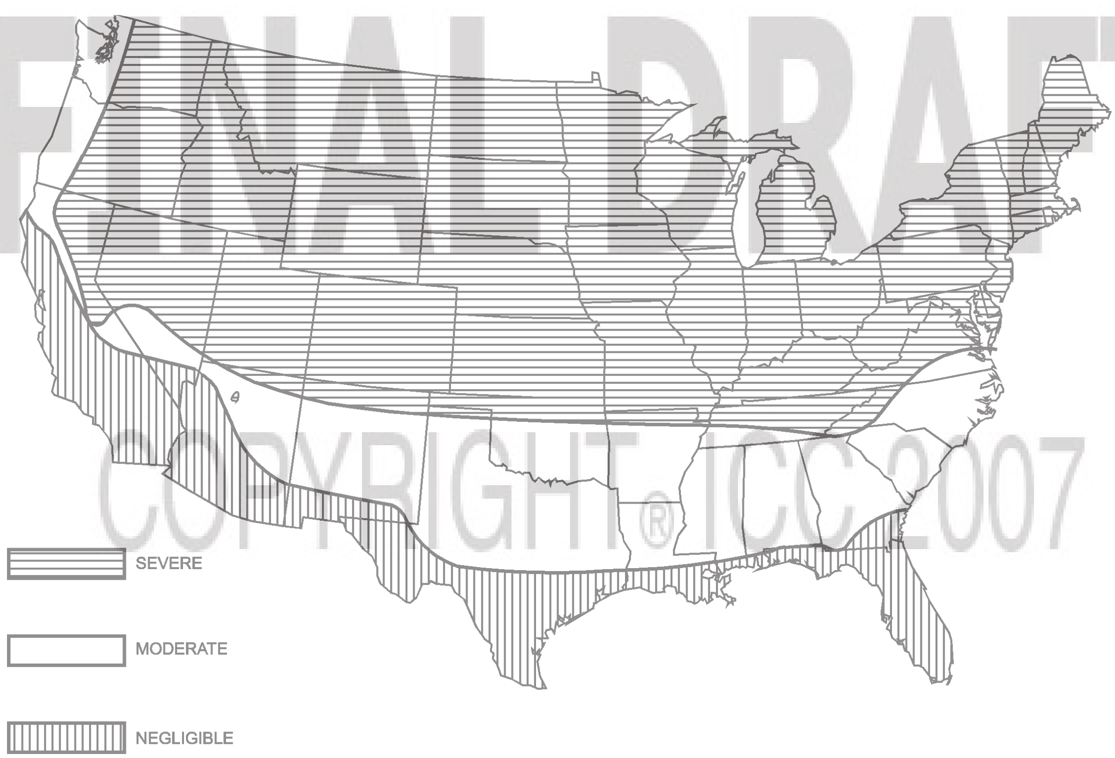


FIGURE 1904.2.2
WEATHERING PROBABILITY MAP FOR CONCRETE[a, b, c]

a. Lines defining areas are approximate only. Local areas can be more or less severe than indicated by the region classification.

b. A "severe" classification is where weather conditions encourage or require the use of deicing chemicals or where there is potential for a continuous presence of moisture during frequent cycles of freezing and thawing. A "moderate" classification is where weather conditions occasionally expose concrete in the presence of moisture to freezing and thawing, but where deicing chemicals are not generally used. A "negligible" classification is where weather conditions rarely expose concrete in the presence of moisture to freezing and thawing.

c. Alaska and Hawaii are classified as severe and negligible, respectively.

1904.3 Sulfate exposures. Concrete that will be exposed to sulfate-containing solutions or soils shall comply with the maximum water-cementitious materials ratios and/or minimum specified compressive strength and be made with the appropriate type of cement in accordance with the provisions of ACI 318, Section 4.3.

1904.4 Corrosion protection of reinforcement. Reinforcement in concrete shall be protected from corrosion and exposure to chlorides in accordance with ACI 318, Section 4.4.

SECTION 1905 CONCRETE QUALITY, MIXING AND PLACING

1905.1 General. The required strength and durability of concrete shall be determined by compliance with the proportioning, testing, mixing and placing provisions of Sections 1905.1.1 through 1905.13.

1905.1.1 Strength. Concrete shall be proportioned to provide an average compressive strength as prescribed in Section 1905.3 and shall satisfy the durability criteria of Section 1904. Concrete shall be produced to minimize the frequency of strengths below f'_c as prescribed in Section 1905.6.3. *For concrete designed and constructed in accordance with this chapter, f'_c shall not be less than 2,500 psi (17.22 MPa).* No maximum specified compressive strength shall apply unless restricted by a specific provision of this code or ACI 318.

1905.2 Selection of concrete proportions. Concrete proportions shall be determined in accordance with the provisions of ACI 318, Section 5.2.

1905.3 Proportioning on the basis of field experience and/or trial mixtures. Concrete proportioning determined on the basis of field experience and/or trial mixtures shall be done in accordance with ACI 318, Section 5.3.

1905.4 Proportioning without field experience or trial mixtures. Concrete proportioning determined without field experience or trial mixtures shall be done in accordance with ACI 318, Section 5.4.

1905.5 Average strength reduction. As data become available during construction, it is permissible to reduce the amount by which the average compressive strength (f'_c) is required to exceed the specified value of f'_c in accordance with ACI 318, Section 5.5.

1905.6 Evaluation and acceptance of concrete. The criteria for evaluation and acceptance of concrete shall be as specified in Sections 1905.6.2 through 1905.6.5.

1905.6.1 Qualified technicians. Concrete shall be tested in accordance with the requirements in Sections 1905.6.2 through 1905.6.5. Qualified field testing technicians shall perform tests on fresh concrete at the job site, prepare specimens required for curing under field conditions, prepare specimens required for testing in the laboratory and record the temperature of the fresh concrete when preparing specimens for strength tests. Qualified laboratory technicians shall perform all required laboratory tests.

1905.6.2 Frequency of testing. The frequency of conducting strength tests of concrete and the minimum number of tests shall be as specified in ACI 318, Section 5.6.2.

Exception: When the total volume of a given class of concrete is less than 50 cubic yards (38 m^3), strength tests are not required when evidence of satisfactory strength is submitted to and approved by the building official.

1905.6.3 Strength test specimens. Specimens prepared for acceptance testing of concrete in accordance with Section 1905.6.2 and strength test acceptance criteria shall comply with the provisions of ACI 318, Section 5.6.3.

1905.6.4 Field-cured specimens. Where required by the building official to determine adequacy of curing and protection of concrete in the structure, specimens shall be prepared, cured, tested and test results evaluated for acceptance in accordance with ACI 318, Section 5.6.4.

1905.6.5 Low-strength test results. Where any strength test (see ACI 318, Section 5.6.2.4) falls below the specified value of f'_c, the provisions of ACI 318, Section 5.6.5, shall apply.

1905.7 Preparation of equipment and place of deposit. Prior to concrete being placed, the space to receive the concrete and the equipment used to deposit it shall comply with ACI 318, Section 5.7.

1905.8 Mixing. Mixing of concrete shall be performed in accordance with ACI 318, Section 5.8.

1905.9 Conveying. The method and equipment for conveying concrete to the place of deposit shall comply with ACI 318, Section 5.9.

1905.10 Depositing. The depositing of concrete shall comply with the provisions of ACI 318, Section 5.10.

1905.11 Curing. The length of time, temperature and moisture conditions for curing of concrete shall be in accordance with ACI 318, Section 5.11.

1905.12 Cold weather requirements. Concrete to be placed during freezing or near-freezing weather shall comply with the requirements of ACI 318, Section 5.12.

1905.13 Hot weather requirements. Concrete to be placed during hot weather shall comply with the requirements of ACI 318, Section 5.13.

SECTION 1906 FORMWORK, EMBEDDED PIPES AND CONSTRUCTION JOINTS

1906.1 Formwork. The design, fabrication and erection of forms shall comply with ACI 318, Section 6.1.

1906.2 Removal of forms, shores and reshores. The removal of forms and shores, including from slabs and beams (except where cast on the ground), and the installation of reshores shall comply with ACI 318, Section 6.2.

1906.3 Conduits and pipes embedded in concrete. Conduits, pipes and sleeves of any material not harmful to concrete and within the limitations of ACI 318, Section 6.3, are permitted to be embedded in concrete with approval of the registered design professional.

1906.4 Construction joints. Construction joints, including their location, shall comply with the provisions of ACI 318, Section 6.4.

SECTION 1907
DETAILS OF REINFORCEMENT

1907.1 Hooks. Standard hooks on reinforcing bars used in concrete construction shall comply with ACI 318, Section 7.1.

1907.2 Minimum bend diameters. Minimum reinforcement bend diameters utilized in concrete construction shall comply with ACI 318, Section 7.2.

1907.3 Bending. The bending of reinforcement shall comply with ACI 318, Section 7.3.

1907.4 Surface conditions of reinforcement. The surface conditions of reinforcement shall comply with the provisions of ACI 318, Section 7.4.

1907.5 Placing reinforcement. The placement of reinforcement, including tolerances on depth and cover, shall comply with the provisions of ACI 318, Section 7.5. Reinforcement shall be accurately placed and adequately supported before concrete is placed.

1907.6 Spacing limits for reinforcement. The clear distance between reinforcing bars, bundled bars, tendons and ducts shall comply with ACI 318, Section 7.6.

1907.7 Concrete protection for reinforcement. The minimum concrete cover for reinforcement shall comply with Sections 1907.7.1 through 1907.7.7.

1907.7.1 Cast-in-place concrete (nonprestressed). Minimum concrete cover shall be provided for reinforcement in nonprestressed, cast-in-place concrete construction in accordance with ACI 318, Section 7.7.1.

1907.7.2 Cast-in-place concrete (prestressed). The minimum concrete cover for prestressed and nonprestressed reinforcement, ducts and end fittings in cast-in-place prestressed concrete shall comply with ACI 318, Section 7.7.2.

1907.7.3 Precast concrete (manufactured under plant control conditions). The minimum concrete cover for prestressed and nonprestressed reinforcement, ducts and end fittings in precast concrete manufactured under plant control conditions shall comply with ACI 318, Section 7.7.3.

1907.7.4 Bundled bars. The minimum concrete cover for bundled bars shall comply with ACI 318, Section 7.7.4.

1907.7.5 Corrosive environments. In corrosive environments or other severe exposure conditions, prestressed and nonprestressed reinforcement shall be provided with additional protection in accordance with ACI 318, Section 7.7.5.

1907.7.6 Future extensions. Exposed reinforcement, inserts and plates intended for bonding with future extensions shall be protected from corrosion.

1907.7.7 Fire protection. When this code requires a thickness of cover for fire protection greater than the minimum concrete cover specified in Section 1907.7, such greater thickness shall be used.

1907.8 Special reinforcement details for columns. Offset bent longitudinal bars in columns and load transfer in structural steel cores of composite compression members shall comply with the provisions of ACI 318, Section 7.8.

1907.9 Connections. Connections between concrete framing members shall comply with the provisions of ACI 318, Section 7.9.

1907.10 Lateral reinforcement for compression members. Lateral reinforcement for concrete compression members shall comply with the provisions of ACI 318, Section 7.10.

1907.11 Lateral reinforcement for flexural members. Lateral reinforcement for compression reinforcement in concrete flexural members shall comply with the provisions of ACI 318, Section 7.11.

1907.12 Shrinkage and temperature reinforcement. Reinforcement for shrinkage and temperature stresses in concrete members shall comply with the provisions of ACI 318, Section 7.12.

1907.13 Requirements for structural integrity. The detailing of reinforcement and connections between concrete members shall comply with the provisions of ACI 318, Section 7.13, to improve structural integrity.

SECTION 1908
MODIFICATIONS TO ACI 318
RESERVED

SECTION 1909
STRUCTURAL PLAIN CONCRETE

1909.1 Scope. The design and construction of structural plain concrete, both cast-in-place and precast, shall comply with the minimum requirements of Section 1909 and ACI 318, Chapter 22, as modified in Section 1908.

1909.1.1 Special structures. For special structures, such as arches, underground utility structures, gravity walls and shielding walls, the provisions of this section shall govern where applicable.

1909.2 Limitations. The use of structural plain concrete shall be limited to:

1. Members that are continuously supported by soil, such as walls and footings, or by other structural members capable of providing continuous vertical support.
2. Members for which arch action provides compression under all conditions of loading.
3. Walls and pedestals.

The use of structural plain concrete columns and structural plain concrete footings on piles is not permitted. See Section 1908.1.15 for additional limitations on the use of structural plain concrete.

1909.3 Joints. Contraction or isolation joints shall be provided to divide structural plain concrete members into flexurally discontinuous elements in accordance with ACI 318, Section 22.3.

1909.4 Design. Structural plain concrete walls, footings and pedestals shall be designed for adequate strength in accordance with ACI 318, Sections 22.4 through 22.8.

Exception: For Group R-3 occupancies and buildings of other occupancies less than two stories in height of light-frame construction, the required edge thickness of ACI 318 is permitted to be reduced to 6 inches (152 mm), provided that the footing does not extend more than 4 inches (102 mm) on either side of the supported wall.

1909.5 Precast members. The design, fabrication, transportation and erection of precast, structural plain concrete elements shall be in accordance with ACI 318, Section 22.9.

1909.6 Walls. In addition to the requirements of this section, structural plain concrete walls shall comply with the applicable requirements of ACI 318, Chapter 22.

1909.6.1 Basement walls. The thickness of exterior basement walls and foundation walls shall be not less than $7^1/_2$ inches (191 mm). Structural plain concrete exterior basement walls shall be exempt from the requirements for special exposure conditions of Section 1904.2.2.

1909.6.2 Other walls. Except as provided for in Section 1909.6.1, the thickness of bearing walls shall be not less than $^1/_{24}$ the unsupported height or length, whichever is shorter, but not less than $5^1/_2$ inches (140 mm).

1909.6.3 Openings in walls. Not less than two No. 5 bars shall be provided around window and door openings. Such bars shall extend at least 24 inches (610 mm) beyond the corners of openings.

SECTION 1910
MINIMUM SLAB PROVISIONS

1910.1 General. The thickness of concrete floor slabs supported directly on the ground shall not be less than $3^1/_2$ inches (89 mm). A 6-mil (0.006 inch; 0.15 mm) polyethylene vapor retarder with joints lapped not less than 6 inches (152 mm) shall be placed between the base course or subgrade and the concrete floor slab, or other approved equivalent methods or materials shall be used to retard vapor transmission through the floor slab.

Exception: A vapor retarder is not required:

1. For detached structures accessory to occupancies in Group R-3, such as garages, utility buildings or other unheated facilities.
2. For unheated storage rooms having an area of less than 70 square feet (6.5 m^2) and carports attached to occupancies in Group R-3.
3. For buildings of other occupancies where migration of moisture through the slab from below will not be detrimental to the intended occupancy of the building.
4. For driveways, walks, patios and other flatwork which will not be enclosed at a later date.
5. Where approved based on local site conditions.

1910.2 Joints. Concrete slabs on ground shall be provided with joints in accordance with ACI 224.3R or other approved methods. Joints shall be designed by an architect or engineer.

Exception: Joints are not required in unreinforced plain concrete slabs on ground or in slabs for one- and two-family dwellings complying with one of the following:

1. Concrete slabs on ground containing synthetic fiber reinforcement. Fiber lengths and dosage amounts shall comply with one of the following
   - 1.1 Fiber lengths shall be $^1/_2$ inch to 2 inches (13 to 51 mm) in length. Dosage amounts shall be from 0.75 to 1.5 pounds per cubic yard (0.45 to 0.89 kg/m^3) in accordance with the manufacturer's recommendations. Synthetic fibers shall comply with ASTM C 1116. The manufacturer or supplier shall provide certification of compliance with ASTM C 1116 when requested by the building official; or,
   - 1.2 Fiber length shall be from $^1/_2$ inch to 2 inches (13 mm to 51 mm) in length, monofilament or fibrillated. Dosage amounts shall be from 0.5 to 1.5 pounds per cubic yard (0.30 to 0.89 kg/m^3) to achieve minimum 40 percent reduction of plastic shrinkage cracking of concrete versus a control mix in accordance with ICBO AC32. Independent test results using minimum six test specimens shall be provided to the building official showing compliance with ICBO A32. Synthetic fiber shall comply with ASTM C 1116, Paragraph 4.1.3, Type III. The manufacturer or supplier shall provide certification of compliance with ASTM C 1116 when requested by building official.
2. Concrete slabs on ground containing 6 × 6 W1.4 × W1.4 welded wire reinforcement fabric located in the middle to the upper one-third of the slab. Welded wire reinforcement fabric shall be supported with approved materials or supports at spacings not to exceed 3 feet (914 mm) or in accordance with the manufacturer's specifications. Welded plain wire reinforcement fabric for concrete shall conform to ASTM A 185, Standard Specification for Steel Welded Wire Reinforcement Fabric, Plain, for Concrete Reinforcement.

SECTION 1911
ANCHORAGE TO CONCRETE—ALLOWABLE STRESS DESIGN

1911.1 Scope. The provisions of this section shall govern the allowable stress design of headed bolts and headed stud anchors cast in normal-weight concrete for purposes of transmitting structural loads from one connected element to the other. These provisions do not apply to anchors installed in hardened concrete. The bearing area of headed anchors shall be not less than one and one-half times the shank area. Where strength design is used, the design strength of anchors shall be determined in accordance with Section 1912. Bolts shall conform to ASTM A 307 or an approved equivalent.

1911.2 Allowable service load. The allowable service load for headed anchors in shear or tension shall be as indicated in Table 1911.2. Where anchors are subject to combined shear and tension, the following relationship shall be satisfied:

$$(P_s / P_t)^{5/3} + (V_s / V_t)^{5/3} \leq 1 \qquad \textbf{(Equation 19-1)}$$

where:

P_s = Applied tension service load, pounds (N).

P_t = Allowable tension service load from Table 1911.2, pounds (N).

V_s = Applied shear service load, pounds (N).

V_t = Allowable shear service load from Table 1911.2, pounds (N).

1911.3 Required edge distance and spacing. The allowable service loads in tension and shear specified in Table 1911.2 are for the edge distance and spacing specified. The edge distance and spacing are permitted to be reduced to 50 percent of the values specified with an equal reduction in allowable service load. Where edge distance and spacing are reduced less than 50 percent, the allowable service load shall be determined by linear interpolation.

1911.4 Increase in allowable load. Increase of the values in Table 1911.2 by one-third is permitted where the provisions of Section 1605.3.2 permit an increase in allowable stress for wind loading.

1911.5 Increase for special inspection. Where special inspection is provided for the installation of anchors, a 100-percent increase in the allowable tension values of Table 1911.2 is permitted. No increase in shear value is permitted.

SECTION 1912 ANCHORAGE TO CONCRETE—STRENGTH DESIGN

1912.1 Scope. The provisions of this section shall govern the strength design of anchors installed in concrete for purposes of transmitting structural loads from one connected element to the other. Headed bolts, headed studs and hooked (J- or L-) bolts cast in concrete and expansion anchors and undercut anchors installed in hardened concrete shall be designed in accordance with Appendix D of ACI 318 as modified by Section 1908.1.16, provided they are within the scope of Appendix D.

> **Exception:** Where the basic concrete breakout strength in tension of a single anchor, N_b, is determined in accordance with Equation (D-7), the concrete breakout strength requirements of Section D.4.2.2 shall be considered satisfied by the design procedures of Sections D.5.2 and D.6.2 for anchors exceeding 2 inches (51 mm) in diameter or 25 inches (635 mm) tensile embedment depth.

The strength design of anchors that are not within the scope of Appendix D of ACI 318, and as amended above, shall be in accordance with an approved procedure.

SECTION 1913 SHOTCRETE

1913.1 General. Shotcrete is mortar or concrete that is pneumatically projected at high velocity onto a surface. Except as specified in this section, shotcrete shall conform to the requirements of this chapter for plain or reinforced concrete.

1913.2 Proportions and materials. Shotcrete proportions shall be selected that allow suitable placement procedures using the delivery equipment selected and shall result in fin-

TABLE 1911.2
ALLOWABLE SERVICE LOAD ON EMBEDDED BOLTS (pounds)

BOLT DIAMETER (inches)	MINIMUM EMBEDMENT (inches)	EDGE DISTANCE (inches)	SPACING (inches)	MINIMUM CONCRETE STRENGTH (psi)					
				f'_c = 2,500		f'_c = 3,000		f'_c = 4,000	
				Tension	Shear	Tension	Shear	Tension	Shear
1/4	2 1/2	1 1/2	3	200	500	200	500	200	500
3/8	3	2 1/4	4 1/2	500	1,100	500	1,100	500	1,100
1/2	4	3	6	950	1,250	950	1,250	950	1,250
	4	5	5	1,450	1,600	1,500	1,650	1,550	1,750
5/8	4 1/2	3 3/4	7 1/2	1,500	2,750	1,500	2,750	1,500	2,750
	4 1/2	6 1/4	7 1/2	2,125	2,950	2,200	3,000	2,400	3,050
3/4	5	4 1/2	9	2,250	3,250	2,250	3,560	2,250	3,560
	5	7 1/2	9	2,825	4,275	2,950	4,300	3,200	4,400
7/8	6	5 1/4	10 1/2	2,550	3,700	2,550	4,050	2,550	4,050
1	7	6	12	3,050	4,125	3,250	4,500	3,650	5,300
1 1/8	8	6 3/4	13 1/2	3,400	4,750	3,400	4,750	3,400	4,750
1 1/4	9	7 1/2	15	4,000	5,800	4,000	5,800	4,000	5,800

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 0.00689 MPa, 1 pound = 4.45 N.

ished in-place hardened shotcrete meeting the strength requirements of this code.

1913.3 Aggregate. Coarse aggregate, if used, shall not exceed $^{3}/_{4}$ inch (19.1 mm).

1913.4 Reinforcement. Reinforcement used in shotcrete construction shall comply with the provisions of Sections 1913.4.1 through 1913.4.4.

1913.4.1 Size. The maximum size of reinforcement shall be No. 5 bars unless it is demonstrated by preconstruction tests that adequate encasement of larger bars will be achieved.

1913.4.2 Clearance. When No. 5 or smaller bars are used, there shall be a minimum clearance between parallel reinforcement bars of $2^{1}/_{2}$ inches (64 mm). When bars larger than No. 5 are permitted, there shall be a minimum clearance between parallel bars equal to six diameters of the bars used. When two curtains of steel are provided, the curtain nearer the nozzle shall have a minimum spacing equal to 12 bar diameters and the remaining curtain shall have a minimum spacing of six bar diameters.

Exception: Subject to the approval of the building official, required clearances shall be reduced where it is demonstrated by preconstruction tests that adequate encasement of the bars used in the design will be achieved.

1913.4.3 Splices. Lap splices of reinforcing bars shall utilize the noncontact lap splice method with a minimum clearance of 2 inches (51 mm) between bars. The use of contact lap splices necessary for support of the reinforcing is permitted when approved by the building official, based on satisfactory preconstruction tests that show that adequate encasement of the bars will be achieved, and provided that the splice is oriented so that a plane through the center of the spliced bars is perpendicular to the surface of the shotcrete.

1913.4.4 Spirally tied columns. Shotcrete shall not be applied to spirally tied columns.

1913.5 Preconstruction tests. When required by the building official, a test panel shall be shot, cured, cored or sawn, examined and tested prior to commencement of the project. The sample panel shall be representative of the project and simulate job conditions as closely as possible. The panel thickness and reinforcing shall reproduce the thickest and most congested area specified in the structural design. It shall be shot at the same angle, using the same nozzleman and with the same concrete mix design that will be used on the project. The equipment used in preconstruction testing shall be the same equipment used in the work requiring such testing, unless substitute equipment is approved by the building official.

1913.6 Rebound. Any rebound or accumulated loose aggregate shall be removed from the surfaces to be covered prior to placing the initial or any succeeding layers of shotcrete. Rebound shall not be used as aggregate.

1913.7 Joints. Except where permitted herein, unfinished work shall not be allowed to stand for more than 30 minutes unless edges are sloped to a thin edge. For structural elements that will be under compression and for construction joints shown on the approved construction documents, square joints are permitted. Before placing additional material adjacent to previously applied work, sloping and square edges shall be cleaned and wetted.

1913.8 Damage. In-place shotcrete that exhibits sags, sloughs, segregation, honeycombing, sand pockets or other obvious defects shall be removed and replaced. Shotcrete above sags and sloughs shall be removed and replaced while still plastic.

1913.9 Curing. During the curing periods specified herein, shotcrete shall be maintained above 40°F (4°C) and in moist condition.

1913.9.1 Initial curing. Shotcrete shall be kept continuously moist for 24 hours after shotcreting is complete or shall be sealed with an approved curing compound.

1913.9.2 Final curing. Final curing shall continue for seven days after shotcreting, or for three days if high-early-strength cement is used, or until the specified strength is obtained. Final curing shall consist of the initial curing process or the shotcrete shall be covered with an approved moisture-retaining cover.

1913.9.3 Natural curing. Natural curing shall not be used in lieu of that specified in this section unless the relative humidity remains at or above 85 percent, and is authorized by the registered design professional and approved by the building official.

1913.10 Strength tests. Strength tests for shotcrete shall be made by an approved agency on specimens that are representative of the work and which have been water soaked for at least 24 hours prior to testing. When the maximum-size aggregate is larger than $^{3}/_{8}$ inch (9.5 mm), specimens shall consist of not less than three 3-inch-diameter (76 mm) cores or 3-inch (76 mm) cubes. When the maximum-size aggregate is $^{3}/_{8}$ inch (9.5 mm) or smaller, specimens shall consist of not less than 2-inch-diameter (51 mm) cores or 2-inch (51 mm) cubes.

1913.10.1 Sampling. Specimens shall be taken from the in-place work or from test panels, and shall be taken at least once each shift, but not less than one for each 50 cubic yards (38.2 m^3) of shotcrete.

1913.10.2 Panel criteria. When the maximum-size aggregate is larger than $^{3}/_{8}$ inch (9.5 mm), the test panels shall have minimum dimensions of 18 inches by 18 inches (457 mm by 457 mm). When the maximum size aggregate is $^{3}/_{8}$ inch (9.5 mm) or smaller, the test panels shall have minimum dimensions of 12 inches by 12 inches (305 mm by 305 mm). Panels shall be shot in the same position as the work, during the course of the work and by the nozzlemen doing the work. The conditions under which the panels are cured shall be the same as the work.

1913.10.3 Acceptance criteria. The average compressive strength of three cores from the in-place work or a single test panel shall equal or exceed 0.85 f'_c with no single core less than 0.75 f'_c. The average compressive strength of three cubes taken from the in-place work or a single test panel shall equal or exceed f'_c with no individual cube less than 0.88 f'_c. To check accuracy, locations represented by erratic core or cube strengths shall be retested.

SECTION 1914
REINFORCED GYPSUM CONCRETE

1914.1 General. Reinforced gypsum concrete shall comply with the requirements of ASTM C 317 and ASTM C 956.

1914.2 Minimum thickness. The minimum thickness of reinforced gypsum concrete shall be 2 inches (51 mm) except the minimum required thickness shall be reduced to $1^1/_2$ inches (38 mm), provided the following conditions are satisfied:

1. The overall thickness, including the formboard, is not less than 2 inches (51 mm).
2. The clear span of the gypsum concrete between supports does not exceed 33 inches (838 mm).
3. Diaphragm action is not required.
4. The design live load does not exceed 40 pounds per square foot (psf) (1915 Pa).

SECTION 1915
CONCRETE-FILLED PIPE COLUMNS

1915.1 General. Concrete-filled pipe columns shall be manufactured from standard, extra-strong or double-extra-strong steel pipe or tubing that is filled with concrete so placed and manipulated as to secure maximum density and to ensure complete filling of the pipe without voids.

1915.2 Design. The safe supporting capacity of concrete-filled pipe columns shall be computed in accordance with the approved rules or as determined by a test.

1915.3 Connections. Caps, base plates and connections shall be of approved types and shall be positively attached to the shell and anchored to the concrete core. Welding of brackets without mechanical anchorage shall be prohibited. Where the pipe is slotted to accommodate webs of brackets or other connections, the integrity of the shell shall be restored by welding to ensure hooping action of the composite section.

1915.4 Reinforcement. To increase the safe load-supporting capacity of concrete-filled pipe columns, the steel reinforcement shall be in the form of rods, structural shapes or pipe embedded in the concrete core with sufficient clearance to ensure the composite action of the section, but not nearer than 1 inch (25 mm) to the exterior steel shell. Structural shapes used as reinforcement shall be milled to ensure bearing on cap and base plates.

1915.5 Fire-resistance-rating protection. Pipe columns shall be of such size or so protected as to develop the required fire-resistance ratings specified in Table 601. Where an outer steel shell is used to enclose the fire protective covering, the shell shall not be included in the calculations for strength of the column section. The minimum diameter of pipe columns shall be 4 inches (102 mm) except that in structures of Type V construction not exceeding three stories or 40 feet (12 192 mm) in height, pipe columns used in the basement and as secondary steel members shall have a minimum diameter of 3 inches (76 mm).

1915.6 Approvals. Details of column connections and splices shall be shop fabricated by approved methods and shall be approved only after tests in accordance with the approved rules. Shop-fabricated concrete-filled pipe columns shall be inspected by the building official or by an approved representative of the manufacturer at the plant.

SECTION 1916
RESERVED

SECTION 1917
LIGHTWEIGHT INSULATING CONCRETE ROOF DECK

1917.1 Lightweight insulating concrete. Material produced with or without aggregate additions to portland cement, water and air to form a hardened material possessing insulating qualities, which, when oven dried shall have a unit weight no greater than 50 pcf (801 kg/m^3).

1917.1.1 Aggregate lightweight insulating concrete. Insulating concrete formulated predominantly with perlite or vermiculite aggregate having a minimum compressive strength of 125 psi (861.8 kPa) when tested in compliance with ASTM C 495.

1917.1.2 Cellular lightweight insulating concrete. Insulating concrete formulated by mixing a hydrated cementitious matrix around noninterconnecting air cells created by the addition of preformed foam formed from hydrolyzed proteins or synthetic surfactants. The cured cellular lightweight insulating concrete shall have minimum compressive strength of 160 psi (1103 kPa) when tested in compliance with ASTM C 495 and C 796.

1917.1.3 Cellular/aggregate (hybrid) lightweight insulating concrete. Insulated concrete formulated by combining preformed foam with low density aggregates to impart properties of both aggregate and cellular lightweight insulating concrete. It shall have a minimum compressive strength of 200 psi (1379 kPa) when tested in compliance with ASTM C 495 and C 796.

1917.1.4 Walkability. A term defining the ability of lightweight insulating concrete to withstand anticipated construction foot traffic during the roof membrane application without significant indentations in the lightweight insulating concrete surface.

1917.2 Inspection.

1917.2.1 Application of all lightweight insulating concrete roof decks shall be by applicators approved by the lightweight insulating concrete deck manufacturer. Product Approval shall be required for all lightweight insulating concrete systems.

1917.2.2 The permit holder shall notify the building official 48 hours prior to the pouring of lightweight insulating concrete.

1917.2.3 The permit holder shall make available to the building official a job log with the following minimum items.

1. Cast density recordings/hour.
2. Product evaluation for application.

3. Date and job locations identified.

4. Results of any field test conducted.

1917.2.4 Once the roof deck system can support foot traffic, the building official shall have clear access and clear path at his option for inspection of lightweight insulating concrete.

1917.3 Testing. The building official may require tests of the lightweight insulating concrete to confirm the fastener withdrawal resistance, compressive strength or drainage ability.

1917.3.1 Existing roof assemblies to receive lightweight insulating concrete other than galvanized G-90 steel deck or structural concrete deck shall be tested for uplift for adhesion to the substrate to confirm compliance with design pressure.

1917.4 Materials and limitations of use. Lightweight insulating concrete, in conjunction with galvanized formed steel sheets, shall not be used as a roof deck in areas where highly corrosive chemicals are used or stored.

1917.4.1 Lightweight insulating concrete shall be poured over bottom slotted galvanized (G-90) steel decking as follows; cellular, 0.5 percent open; hybrid, 0.75 percent open, aggregate 1.5 percent open. No lightweight insulating concrete shall be poured over a painted or non-galvanized steel deck.

1. Lightweight insulating concrete over structural concrete slabs, twin tees, precast units or other non venting substrates shall be vented to allow the escape of excess moisture.

1917.4.2 Minimum thickness of lightweight insulating concrete shall be 2 inches (51 mm) over the top plane of the substrate unless otherwise specified in the Product Approval. Lightweight insulating concrete shall be of sufficient thickness to receive the specified base ply fastener length.

1917.4.3 Reserved.

1917.4.4 Galvanized coatings of formed steel sheets shall be in accordance with ASTM A 525 with a minimum coating designation of G-90. Base steel shall conform to ASTM A 446, Grade A, B, C, D or greater and ASTM A 611 C, D or E.

1917.4.5 Chemical admixtures shall be in compliance with ASTM C 494. Calcium chloride or any admixture containing chloride salts shall not be used in insulating concrete. Fiber reinforcement may be used to control cracking. Mineral admixtures shall conform to ASTM C618.

1917.4.6 Vermiculite or perlite shall be in compliance with ASTM C332, Group I. Foam concentrates shall be in compliance with ASTM C796 and ASTM C869.

1917.4.7 Mixing, placing and finishing shall be in compliance with the deck system Product Approval. Slurry coating, two-density casting and double casting shall be acceptable per the specific manufacturer's recommendations.

1917.4.8 If the lightweight insulating concrete deck is to receive Product Approval for a direct-adhered roofing system, the deck surface shall be prepared to the requirements set forth in the roof system Product Approval.

1917.4.9 All base ply fasteners for use in lightweight insulating concrete roof decks shall have a Product Approval for use with the specific lightweight insulating concrete roof system in compliance with manufacturer's recommendations and the design pressure of Section 1609.

1917.4.10 The lightweight insulating concrete fastener withdrawal shall have a minimum resistance for new pours of

1. 60 pounds (267 N) in 28 days when the fastener is installed and allowed to age in the concrete.
2. 40 pounds (178 N) at time of roofing.

1917.4.11 Lightweight insulating concrete system expansion joints shall be provided at the following locations:

1. Where expansion joints are provided in the structural assembly.
2. Where steel framing, structural steel or decking change direction
3. Where separate wings of "L," "U," "T" or similar configurations exist
4. Where the type of decking changes (for example, where a precast concrete deck and a steel deck abut)
5. Whenever additions are connected to existing buildings.
6. At junctions where interior heating conditions change
7. Wherever differential movement between vertical walls and the roof deck may occur.

1917.4.12 Insulation board with lightweight insulating concrete shall conform to Type I expanded polystyrene insulation as defined in ASTM C578.

1. Packaged insulation board delivered to the job site shall comply with the provisions of Section 2603.2 or Section 2612.1.3.
2. Installation of insulating board in conjunction with lightweight insulating concrete shall comply with uplift requirements set forth in Section 1609. Insulation panels shall be placed in a minimum $^{1}/_{8}$-inch (3.2 mm) slurry bed of insulating concrete while the material is still in a plastic state. The insulating concrete shall be cast over the insulation boards according to the insulating concrete manufacturer's Product Approval. Insulation panels shall be provided with holes and/or slots for keying and venting.

1917.4.13 Reinforcing mesh shall be provided as required to meet fire-rating and/or special structural design requirements. Refer to a specific Product Approval for the specific requirements applicable to the product being installed.

SECTION 1918
SPECIAL WIND PROVISIONS FOR CONCRETE

1918.1 Reinforced concrete components. The design and construction of reinforced concrete components for buildings sited in areas with a basic wind speed greater than 100 mph (45 m/s) in accordance with Figure 1609 shall conform to the requirements of ACI 318 or with Section 1609.1.1, Exception 3, as applicable, except as modified in this section.

1918.2 Insulated concrete form wall. Insulated concrete form (ICF) wall construction for buildings shall be in accordance with ACI 318 or with Section 1609.1.1, Exception 3, as applicable.

1918.3 Gable endwalls.

1918.3.1 General. Gable endwalls shall be structurally continuous between points of lateral support.

1918.3.2 Cathedral endwalls. Gable endwalls adjacent to cathedral ceilings shall be structurally continuous from the uppermost floor to ceiling diaphragm or to the roof diaphragm.

SECTION 1919 HIGH-VELOCITY HURRICANE ZONES—GENERAL

1919.1 Scope. This section prescribes requirements for reinforced concrete in construction regulated by this code.

1919.2 Application. Reinforced concrete shall be of the materials, proportions strength and consistency as set forth in this section and shall be designed by methods admitting of rational analysis according to established principles of mechanics.

1919.3 Requirements. All structures of reinforced concrete, including prestressed concrete, shall be designed and constructed in accordance with the provisions of ACI 318 as adopted herein.

1919.4 Workmanship. Concrete construction shall be in conformance with the tolerance, quality and methods of construction set forth in Section1920.

SECTION 1920 HIGH-VELOCITY HURRICANE ZONES — STANDARDS

1920.1 The following standards are hereby adopted as part of this code as set forth in Chapter 35 of this code.

1920.2 American Concrete Institute (ACI).

1. Standard Tolerances for Concrete Construction and Materials, ACI 117.
2. Specifications for Structural Concrete for Buildings, ACI 301.
3. Manual of Standard Practice for Detailing Reinforced Concrete Structures, ACI 315.
4. Building Code Requirements for Reinforced Concrete, ACI 318.
5. Recommended Practice for Concrete Formwork, ACI 347.
6. Recommended Practice for Shotcreting, ACI 506.
7. Specification for Materials, Proportioning, and Application of Shotcrete, ACI 506.2.
8. Deformed and Plain Billet Steel Bars for Concrete Reinforcement, ASTM A615, including S1.

1920.3 American National Standards Institute (ANSI)/American Society of Civil Engineers (ASCE).

1. Specifications for the Design and Construction of Composite Slabs and Commentary on Specifications for the Design and Construction of Composite Slabs, ANSI/ASCE 3.
2. Guideline for Structural Assessment of Existing Buildings, ANSI/ASCE 11.

1920.4 American Society for Testing Materials (ASTM).

1. Deformed and Plain Billet Steel Bars for Concrete Reinforcement, ASTM A 615, including S1.
2. Testing Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation, ASTM C 1077.

SECTION 1921 HIGH-VELOCITY HURRICANE ZONES— DEFINITIONS

1921.1 The following definitions apply to the provisions of Sections 1919 through 1929.

PLAIN CONCRETE. Concrete that is either unreinforced or contains less reinforcement than the minimum amount specified for reinforced concrete.

REINFORCED CONCRETE. Concrete reinforced with no less than the minimum amount required by ACI 318, prestressed or non-prestressed, and designed on the assumption that the two materials act together in resisting forces.

PRESTRESSED CONCRETE. Reinforced concrete in which internal stresses have been introduced to reduce potential tensile stresses in concrete resulting from loads, The term prestressed concrete refers to pretensioned concrete in which the reinforcing is tensioned before hardening of the concrete, to postensioned concrete in which the reinforcing is tensioned after hardening of the concrete, or combinations of both pretensioning and posttensioning.

PRECAST CONCRETE. Plain or reinforced concrete elements cast elsewhere than their final position in a structure.

SHOTCRETE. Mortar or concrete pneumatically projected at high velocity onto a surface.

SECTION 1922 HIGH-VELOCITY HURRICANE ZONES— MATERIALS

1922.1 Cements. Cements shall conform to one of the following specifications for portland cement as set forth in Chapter 35.

1. Portland Cement, ASTM C 150.
2. Blended Hydraulic Cements, ASTM C 595, excluding Types S and SA, which are not intended as principal cementing constituents of structural concrete.

1922.2 Aggregates for concrete shall conform to one of the following specifications as set forth in Chapter 35 of this code or Section 1922.2.1.

1. Concrete Aggregates, ASTM C 33.

2. Lightweight Aggregates for Structural Concrete, ASTM C 330.

1922.2.1 Gradation of locally produced sand and crushed rock aggregate shall be as follows:

COARSE AGGREGATE

Percent Passing

$1^1/_2$ inches	sieve	100
1 inches	sieve	95 - 100
1/2 inches	sieve	25 - 60
#4	sieve	0 - 10
#8	sieve	0 - 5

FINE AGGREGATE

Percent Passing

3/8 inches	sieve	100
#4	sieve	90 - 100
#8	sieve	70 - 95
#16	sieve	50 - 85
#30	sieve	30 - 70
#50	sieve	10 - 45
#100	sieve	0 - 10

1922.2.2 Aggregates failing to meet ASTM C 33, ASTM C 330 or the above special gradation but which have been shown by special test or actual service to produce concrete of adequate strength and durability may be used when certified by the engineer.

1922.2.3 Aggregates shall be quarried or washed in fresh water and shall contain not more than 1/20 of 1-percent salt by weight.

1922.3 Water used in mixing concrete shall be clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials or other substances that may be deleterious to concrete or reinforcement.

1922.3.1 Mixing water for concrete, including that portion of mixing water contributed in the form of free moisture on aggregates, shall not contain deleterious amounts of chloride ion.

1922.4 Reinforcement.

1922.4.1 Deformed reinforcement shall conform to one of the specifications as set forth in Chapter 35, except as provided in Section 3.5 of ACI 318.

1922.4.2 Prestressing tendons shall conform to one of the specifications as set forth in Chapter 35.

Exception: Wire strands and bars not specifically listed in ASTM A 421, A 416, or A 722 may be used provided they conform to minimum requirements of these specifications and do not have properties that make them less satisfactory than those listed in ASTM A 416, A 421 or A 722.

1922.4.3 Reinforcement consisting of structural steel, steel pipe or steel tubing may be used as specified in ACI 318.

1922.4.4 All welding of reinforcement shall conform to the Structural Welding Code - Reinforcing Steel, AWS D1.4, as set forth in Chapter 35.

1922.4.5 Reinforcement to be welded shall be indicated on the drawings, and welding procedures to be used shall be specified. ASTM steel specifications, except ASTM A 706, shall be supplemented to require a report of material properties necessary to conform to welding procedures specified in AWS D1.4.

1922.4.6 Deformed reinforcement may be galvanized or epoxy-coated in accordance with the Specifications for Zinc-Coated (galvanized) Bars for Concrete reinforcement, ASTM A 767 or the Specification for Epoxy-Coated Bars, ASTM A 775. Zinc or epoxy-coated reinforcement shall conform to ASTM A 615, A 616 (S1), A 617 or A 706.

1922.5 Admixtures.

1922.5.1 Admixtures to be used in concrete shall conform to one of the specifications set forth in Chapter 35.

1922.5.2 An admixture shall be shown capable of maintaining essentially the same composition and performance throughout the work as the product used in establishing concrete proportions.

1922.5.3 Admixtures containing chloride ions shall not be used in concrete if their use will produce a deleterious concentration of chloride ion in the mixing water.

1922.6 Test of materials.

1922.6.1 The building official, or his or her authorized representative, shall have the right to order the test of any material entering into concrete or reinforced concrete to determine its suitability for the purpose; to order reasonable tests of the concrete from time to time to determine whether the materials and methods in use are such as to produce concrete of the necessary quality; and to order the test under load of any portion of a completed structure when conditions have been such as to leave doubt as to the adequacy of the structure to serve the purpose for which it is intended.

1922.6.2 Materials and of concrete shall be tested in accordance with applicable standards of ASTM International as listed in Chapter 35. Tests shall be made by an approved testing laboratory and results of such tests shall be submitted to the building official. Approved testing laboratories shall comply with ASTM C 1077.

1922.6.3 A complete record of tests of materials and of concrete shall be available to the building official for inspection during progress of work and for five years after completion of the project, and shall be preserved by the inspecting engineer or architect for that purpose.

1922.6.4 If doubt develops concerning the safety of a structure or member, the building official may order a structural strength investigation by analysis or by means of load tests, or by a combination of analyses and load test as set forth in Chapter 20 of ACI 318.

SECTION 1923
HIGH-VELOCITY HURRICANE ZONES—CONCRETE QUALITY

1923.1 General.

1923.1.1 Concrete shall be proportioned and produced to provide an average compressive strength sufficiently high to minimize the frequency of strength test below the specified compressive strength of concrete, $f'c$.

1923.1.2 Requirements for $f'c$ shall be based on tests of cylinders made and tested as prescribed in Section 1923.2.2.3.

1923.1.3 Unless otherwise specified, $f'c$ shall be based on 28-day tests. If other than 28-day tests are called for, $f'c$ shall be indicated in design drawings or specifications.

1923.1.4 Design drawings shall show the specified compressive strength of concrete, $f'c$ for which each part of the structure is designed.

1923.2 Evaluation and acceptance concrete.

1923.2.1 Frequency of testing.

1923.2.1.1 The building official may require a reasonable number of tests to be made during the progress of the work, or may promulgate and set forth in writing such reasonable rules for requiring tests to be made by an approved laboratory as he may consider necessary to insure compliance with this code.

1923.2.1.2 Not less than three specimens shall be made for each standard test.

1923.2.1.3 Samples for strength of each class of concrete placed each day shall be taken not less than once a day, nor less than once for each 150 cubic yard (4.3 m^3) of concrete, nor less than once for each 5,000 square feet (465 m^2) of surface area for slabs or walls.

1923.2.1.4 On a given project, if total volume of concrete is such that frequency of testing required by Section 1923.2.1.1 would provide less than five strength tests for a given class of concrete, tests shall be made from at least five randomly selected batches or from each batch if fewer than five batches are used.

1923.2.1.5 Test cylinders taken on truck-mixed concrete shall be taken at the approximate one-quarter point of the load.

1923.2.1.6 The age for strength tests shall be 28 days, or where specified, at the earlier age at which the concrete is to receive its full working load.

1923.2.2 Laboratory cured specimens.

1923.2.2.1 A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at a test age designated for determination of $f'c$.

1923.2.2.2 Samples of strength tests shall be taken in accordance with the Method of Sampling Fresh Concrete, ASTM C 172, as set forth in Chapter 35.

1923.2.2.3 Cylinders for strength tests shall be molded and laboratory-cured in accordance with the Method of Making and Curing Concrete Test Specimens in the Field, ASTM C 31, as set forth in Chapter 35 of this code, and tested in accordance with the Method of Test for Compressive Strength of Cylindrical Concrete Specimens, ASTM C 39, as set forth in Chapter 35.

1923.2.2.4 The strength level of an individual class of concrete shall be considered satisfactory if both of the following requirements are met:

1. Average of all sets of three consecutive strength tests equal or exceed $f'c$.
2. No individual strength test (average of 2 cylinders) falls below $f'c$ by more than 500 psi (3448 kPa).

1923.2.2.5 If any of the requirements of Section 1923.2 are not met, steps shall be taken to increase the average of subsequent strength test results. Requirements of Section 1923.2.4 shall be observed if any individual strength test falls below $f'c$ by more than 500 psi (3448 kPa).

1923.2.3 Field cured specimens.

1923.2.3.1 The building official may require strength tests of cylinders cured under field conditions to check adequacy of curing and protection of concrete in the structure.

1923.2.3.2 Field-cured cylinders shall be cured under field conditions in accordance with Section 7.4 of the Method of Making and Curing Concrete Test specimens in the Field, ASTM C 31.

1923.2.3.3 Field-cured test cylinders shall be molded at the same time and from the same samples as laboratory-cured test cylinders.

1923.2.3.4 Procedures for protecting and curing concrete shall be improved when the strength of field-cured cylinders at test age designated for determination of $f'c$ is less than 85 percent of that of companion laboratory cured cylinders. The 85 percent may be waived if field cured strength exceeds $f'c$ by more than 500 psi (3448 Pa).

1923.2.4 Investigation of low strength test results.

1923.2.4.1 When there is a question as to the quality of the concrete in the structure, the building official may require core tests in accordance with the Standard Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete, ASTM C 42, as set forth in Chapter 35 of this code, or order load tests on that portion of the structure where the questionable concrete has been placed.

1923.2.4.2 When concrete in structures has failed to meet the minimum standard, the building official shall order analysis and reports by a registered engineer to determine the adequacy of the structure.

1923.2.4.3 If the likelihood of low-strength concrete is confirmed and computations indicate that load-carrying capacity may have been significantly reduced, tests of cores drilled from the area in question may be required in accordance with the Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete, ASTM C 42, as set forth in Chapter 35 of this code. In such case, three cores shall be taken for each strength test more than 500 psi (3448 kPa) below specified value of $f'c$.

1923.2.4.4 If concrete in the structure will be dry under service conditions, cores shall be air dried at a temperature between 60°F (15ºC) and 80ºF (27°) and a relative humidity less than 60 percent for 7 days before testing and shall be tested dry. If concrete in the structure will be more than superficially wet under service conditions, cores shall be immersed in water for at least 40 hours and be tested wet.

1923.2.4.5 Concrete in an area represented by core tests shall be considered structurally adequate if the average of three cores is equals to at least 85 percent of f ¢c and if no single core is less than 75 percent of $f'c$. To check testing accuracy, locations represented by erratic core strengths may be retested.

1923.2.4.6 Slump considerations. The maximum allowable slump of concrete shall be 6 inches (152 mm). On jobs controlled and supervised by a professional engineer, this maximum may be exceeded, but no concrete shall exceed the slump as indicated on the approved plans for proposed work.

SECTION 1924 HIGH-VELOCITY HURRICANE ZONES— MIXING AND PLACING CONCRETE

1924.1 Preparation of equipment and place of deposit.

1924.1.1 Preparation before concrete placement shall include the following:

1. All equipment for mixing and transporting concrete shall be clean.
2. All debris shall be removed from the spaces to be occupied by the concrete.
3. Forms shall be properly coated.
4. Masonry filler units that will be in contact with concrete shall be well drenched.
5. Reinforcement shall be thoroughly cleaned of deleterious coatings.
6. Water shall be removed from place of deposit before concrete is placed unless a tremie is to be used or unless otherwise permitted by the professional engineer.
7. All laitance and other unsound material shall be removed before additional concrete is placed against hardened concrete.

1924.2 Mixing.

1924.2.1 All concrete shall be mixed until there is uniform distribution of materials and shall be discharged completely before the mixer is recharged.

1924.2.2 Ready-mixed concrete shall be mixed and delivered in accordance with requirements of the Specifications for Ready-Mixed Concrete, ASTM C 94, or the Specifications for Concrete Made by Volumetric Batching and Continuous Mixing, ASTM C 685, as set forth in Chapter 35 of this code.

1924.2.3 Job-mixed concrete shall be mixed in accordance with the following:

1. Mixing shall be done in a batch mixer of approved type.
2. Mixer shall be rotated at a speed recommended by the manufacturer.
3. Mixing shall be continued for at least 11/2 minutes after all materials are in the drum, unless a shorter time is shown to be satisfactory by the mixing uniformity test of Specification for Ready-Mixed Concrete, ASTM C 94.
4. Materials handling, batching, and mixing shall conform to applicable provisions of the Specifications for Ready-Mixed Concrete, ASTM C 94.
5. A detailed record shall be kept to identify:
   - 5.1. Number of batches produced.
   - 5.2. Proportions of materials used.
   - 5.3. Approximate location of final deposit in structure.
   - 5.4. Time and date of mixing and placing.

1924.3 Conveying.

1924.3.1 Concrete shall be conveyed from mixer to the place of final deposit by methods that will prevent separation or loss of the materials.

1924.3.2 Conveying equipment shall be capable of providing a supply of concrete at the site of placement without separation of ingredients and without interruptions sufficient to permit loss of plasticity between successive increments.

1924.4 Depositing.

1924.4.1 Concrete shall be deposited as nearly as practicable in its final position to avoid segregation caused by rehandling or flowing.

1924.4.2 Concreting shall be carried on at such a rate that concrete is at all times plastic and flows readily into the spaces between reinforcement.

1924.4.3 Concrete that has partially hardened or been contaminated by foreign materials shall not be deposited in the structure.

1924.4.4 Retempered concrete or concrete that has been remixed after initial set shall not be used unless approved by the building official.

1924.4.5 After concreting is started, it shall be carried on as a continuous operation until placing of the panel or section, as defined by its boundaries or predetermined joints is completed except as permitted or prohibited by Section 1925.4.

1924.4.6 Top surfaces of vertically formed lifts shall be generally level.

1924.4.7 When construction joints are required, joints shall be made in accordance with Section 1925.4.

1924.4.8 All concrete shall be thoroughly consolidated by suitable means during placement and shall be thoroughly worked around the reinforcement and embedded fixtures and into corners of forms.

1924.5 Curing.

1924.5.1 Concrete, other than high-early-strength, shall be maintained in a moist condition for as least the first seven days after placement, except when cured in accordance with Section 1924.5.3.

1924.5.2 High-early-strength concrete shall be maintained in a moist condition for at least the first three days, except when cured in accordance with Section 1924.5.3.

1924.5.3 Accelerated curing.

1. Curing by high-pressure steam, steam at atmospheric pressure, heat and moisture, or other accepted processes, may be employed to accelerate strength gain and reduce time of curing.
2. Accelerated curing shall provide a compressive strength of the concrete at the load stage considered at least equal to required design strength at that load stage.
3. The curing process shall produce concrete with a durability at least equivalent to the curing method of Section 1924.5.3, Items 1 or 2.
4. Supplementary strength tests in accordance with Section 1923.2.3 may be required to ensure that curing is satisfactory.

1924.6 Bonding.

1924.6.1 Before fresh concrete is deposited or placed on or against concrete which has hardened for 8 hours or longer, the forms shall be retightened, the surface of the hardened concrete shall be cleaned of all foreign matter and laitance, and dampened, but not saturated. Fresh concrete shall not be deposited or placed on or against hardened concrete so dampened before the surface is completely free of shiny spots indicating free moisture. When the concrete against which fresh concrete will be placed is less than 8 hours old, all laitance, loose particles and dirt shall be removed.

1924.6.2 Where bonding of fresh to hardened concrete is necessary, construction joints and joints between footings and walls or columns, between walls or columns and beams or floors they support, and joints in unexposed walls shall be accomplished by reinforcement, dowels, adhesives, mechanical connectors or other approved methods. Hardened concrete at joints shall be dampened, but not saturated, immediately prior to the placement of fresh concrete.

SECTION 1925
HIGH-VELOCITY HURRICANE ZONES—FORMWORK, EMBEDDED PIPES AND CONSTRUCTION JOINTS

1925.1 Design of formwork.

1925.1.1 Forms shall be designed in accordance with ACI 347, Recommended Practice for Concrete Formwork.

1925.1.2 Forms shall result in a final structure that conforms to shapes, lines and dimensions of the members as required by the design drawings and specifications.

1925.1.3 Forms shall be substantial and sufficiently tight to prevent leakage of mortar.

1925.1.4 Forms shall be properly braced or tied together to maintain position and shape.

1925.1.5 Forms and their supports shall be designed so as not to damage previously placed structures.

1925.1.6 Design of formwork shall include consideration of the rate and method of placing concrete; construction loads, including vertical, horizontal and impact loads; and special form requirements for construction of shells, folded plates, domes, architectural concrete or similar types of elements.

1925.1.7 Forms for prestressed concrete members shall be designed and constructed to permit movement of the member without damage during application of prestressing force.

1925.2 Removal of forms and shores.

1925.2.1 No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with the remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.

1925.2.2 Sufficient strength shall be demonstrated by structural analysis considering proposed loads, strength of the forming and shoring system and concrete strength data. Concrete strength data may be based on tests of field-cured cylinders or, when approved by the building official, on other procedures to evaluate concrete strength. Structural analysis and concrete strength test data shall be furnished to the building official when so required.

1925.2.3 No construction loads exceeding the combination of superimposed dead load plus specified live load shall be supported on any unshored portion of the structure under construction, unless analysis indicated adequate strength to support such additional loads.

1925.2.4 Forms shall be removed in a manner that does not impair the safety and serviceability of the structure. All concrete to be exposed by form removal shall have sufficient strength not to be damaged thereby.

1925.2.5 Form supports for prestressed concrete members may be removed when sufficient prestressing has been applied to enable prestressed members to carry their dead load and anticipated construction loads.

1925.3 Conduits and pipes embedded in concrete.

1925.3.1 Conduits, pipes and sleeves of any material not harmful to concrete, and with limitations of this section, may be embedded in concrete with approval of the professional engineer provided they are not considered to structurally replace the displaced concrete.

1925.3.2 Conduits or pipes of aluminum shall not be embedded in structural concrete unless effectively coated or covered to prevent aluminum-concrete reaction or electrolytic action between aluminum and steel.

1925.3.3 Conduits, pipes and sleeves passing through a slab, wall or beam shall not impair the strength of the construction.

1925.3.4 Conduits and pipes, with their fittings, embedded within a column shall not displace more than 4 percent of the area of cross section on which strength is calculated or which is required for fire protection.

1925.3.5 Except when plans for conduits and pipes are approved by the professional engineer and other than those merely passing through, conduits and pipes embedded within a slab, wall or beam shall satisfy the following:

1. They shall not be larger in outside dimension than three-eights of the overall thickness of slab, wall or beam in which they are embedded.
2. They shall not be spaced closer than three diameters or widths on center.
3. They shall not impair the strength of the construction.

1925.3.6 Conduits, pipes and sleeves may be considered as replacing structurally in compression the displaced concrete, provided:

1. They are not exposed to rusting or other deterioration.
2. They are of uncoated or galvanized iron or steel not thinner than standard Schedule 40 steel pipe, and
3. They have a nominal inside diameter not over 2 inches (51 mm) and are spaced not less than three diameters on centers.

1925.3.7 In addition to other requirements of Section 1925.3 pipes that will contain liquid, gas or vapor may be embedded in structural concrete under the following conditions:

1. Pipes and fittings shall be designed to resist effects of the material, pressure and temperature to which they will be subjected.
2. Temperature of liquid, gas or vapor shall not exceed 150ºF (66ºC).
3. Maximum pressure to which any piping or fittings shall be subjected shall not exceed 200 psi (1379 kPa) above atmospheric pressure.
4. All piping and fittings except as provided in Section 1925.3.5 shall be tested as a unit for leaks before concrete placement. Testing pressure above atmospheric pressure shall be 50 percent in excess of pressure to which piping and fittings may be subjected, but minimum testing pressure shall not be less than 150 psi (1034 kPa) above atmospheric pressure. Pressure test shall be held for 4 hours with no drop in pressure except that which may be caused by air temperature.
5. Drain pipes and other piping designed for pressures of not more than 1 psi (7 kPa) above atmospheric pressure need not be tested as required in Section 1925.3.7(4).
6. Pipes carrying liquid, gas or vapor that is explosive or injurious to health shall be tested again as specified in Section 1925.3.7(4) after concrete has hardened.
7. No liquid, gas or vapor, except water not exceeding 90ºF (32ºC) nor 50 psi (350 kPa) pressure, shall be placed in the pipes until the concrete has attained its design strength.
8. Unless piping in solid slabs is for radiant heating, it shall be placed between top and bottom reinforcement.
9. Concrete cover for pipes and fittings shall not be less than $1^{1}/_{2}$ inches (38 mm) for concrete exposed to earth or weather, nor $^{3}/_{4}$ inch (19 mm) for concrete not exposed to weather or in contact with ground.
10. Reinforcement with an area not less than 0.002 times the area of concrete section shall be provided normal to the piping.
11. Piping and fittings shall be assembled by welding, brazing, solder sweating or other equally satisfactory methods. Screw connections shall not be permitted. Piping shall be so fabricated and installed that cutting, bending or displacement of reinforcement from its proper location will not be required.

1925.4 Construction joints.

1925.4.1 Surfaces of the concrete construction joints shall be cleaned and laitance removed.

1925.4.2 Immediately before new concrete is placed, all construction joints shall be wetted and standing water removed.

1925.4.3 Construction joints shall be so made and located as not to impair the strength of the structure. Provision shall be made for transfer of shear and other forces through construction joints.

1925.4.4 Construction joints in floors shall be located near the middle of the spans of slabs, beams or girders, unless a beam intersects a girder at the middle location, in which case, joints in the girders shall be offset a distance approximately twice the width of the beam.

1925.4.5 Beams, girders or slabs supported by columns or walls shall not be cast or erected until concrete in the vertical support members is no longer plastic.

1925.4.6 Beams, girders, haunches, drop panels and capitals shall be placed monolithically as part of a slab system, unless otherwise shown on design drawing.

SECTION 1926
HIGH-VELOCITY HURRICANE ZONES—DETAILS OF REINFORCEMENT

1926.1 Bending reinforcement.

1926.1.1 All reinforcement shall be bent cold, unless otherwise permitted by the professional engineer.

1926.1.2 Reinforcement partially embedded in concrete shall not be field bent, except as shown on the design drawings or permitted by the professional engineer.

1926.2 Surface conditions of reinforcement.

1926.2.1 At the time concrete is placed, reinforcement shall be free from mud, oil or other nonmetallic coatings that adversely affect bonding capacity.

1926.2.2 Steel reinforcement, except prestressing tendons, with rust, mill scale or a combination of both shall be considered satisfactory, provided the minimum dimensions, including the height of deformations and weight of a hand-wire-brushed test specimen, are not less than applicable ASTM specification requirements.

1926.2.3 Prestressing tendons shall be clean and free of oil, dirt, scale, pitting and excessive ruts. A light oxide is permissible.

1926.3 Placing reinforcement.

1926.3.1 Steel reinforcement shall be accurately placed and adequately secured in position by concrete or metal chairs, spacers or other acceptable methods. The minimum clear distance between parallel bars, except in columns, shall be equal to the nominal diameter of the bars. In no case shall the clear distance between bars be less than 1 inch (25 mm), or less than one and one-third times the maximum size of the coarse aggregate. When reinforcement in beams or girders is placed in two or more layers, the clear distance between layers shall not be less than 1 inch (25 mm) nor less than the diameter of the bars, and the bars in the upper layers shall be placed directly above those in the bottom layer.

1926.3.2 Unless otherwise permitted by the building official and professional engineer, reinforcement, prestressing tendons and prestressing ducts shall be placed within the following tolerances:

1. Tolerance for depth, d, and minimum concrete cover in flexural members, walls and compression members shall be as follows, where d represents the distance from the extreme compression fiber to the centroid of the tension reinforcement:

	Tolerance on d	Tolerance on minimum concrete cover
d < 8 in.	+/- 3/8 in.	- 3/8 in.
d > 8 in.	+/- 1/2 in.	- 1/2 in.

Exceptions:

a. Tolerance for the clear distance to formed soffits shall be minus $\frac{1}{4}$ inch (6.3 mm).

b. Tolerance for cover shall not exceed minus one-third the minimum concrete cover required in the contract drawings nor less than 1 inch (25 mm) when exposed to weather.

2. Tolerance for longitudinal location of bends and ends of reinforcement shall be + 2 inches (+ 51 mm) except at discontinuous ends of members where tolerance shall be + $\frac{1}{2}$ inch (+ 12.7 mm).

1926.3.3 Welded wire fabric with a wire size not greater than W5 or D5 used in slabs not exceeding 10 feet (3 m) in span may be curved from a point near the top of the slab over the support to a point near the bottom of the slab at midspan, provided such reinforcement is either continuous over, or securely anchored at, the support.

1926.3.4 Welding of crossing bars shall not be permitted for assembly of reinforcement unless approved by the professional engineer of record.

1926.3.5 Spacing limits and concrete cover for reinforcement shall be shown on the design drawings.

1926.4 Splices in reinforcement.

1926.4.1 In slabs, beams and girders, splices in reinforcement at points of maximum stress shall be avoided wherever possible. Such splices, where used, shall be welded, lapped or otherwise fully developed, but, in any case, shall transfer the entire stress from bar to bar without exceeding the allowable bond and shear stresses. The minimum overlap for a lapped splice shall be 24 bar diameters, but not less than 12 inches (25 mm) for bars and in accordance with Section 12.15 and 12.16 of ACI 318. The clear distance between bars shall also apply to the clear distance from a contact splice and adjacent splices or bars.

1926.4.2 Reinforcement shall be spliced only as required or permitted on design drawings, or in specifications or as authorized by the professional engineer of record.

1926.4.3 Lap splices shall not be used for bars larger than #11 except as provided in ACI 318.

1926.4.4 Lap splices of bundled bars shall be based on the lap splice length required for individual bars within a bundle, increased 20 percent for a 3-bar bundle and 33 percent for a 4-bar bundle. Individual bar splices within a bundle shall not overlap.

1926.4.5 Bars spliced by noncontact lap splices in flexural members shall not be spaced transversely farther apart than one-fifth the required lap splice length, nor 6 inches (152 mm).

1926.4.6 Welded splices may be used, provided the metallurgical properties of the bars are suitable as determined by the professional engineer of record in accordance with AWS D1.4.

1926.4.7 End bearing splices.

1926.4.7.1 In bars required for compression only, compressive stress may be transmitted by bearing of square cut ends held in concentric contact by a suitable device.

1926.4.7.2 Bar ends shall terminate in flat surfaces within $1\frac{1}{2}$ degrees of a right angle to the axis of the bars and shall be fitted within 3 degrees of full bearing after assembly.

1926.4.7.3 End bearing splices shall be used only in members containing closed ties, closed stirrups or spirals.

1926.4.8 Welded splices in reinforcing bars shall be made by certified welders and shall comply with the Standard Structural Welding Code-Reinforcing Steel, AWS D1.4, as set forth in Chapter 35 of this code.

1926.5 Concrete protection for reinforcement (nonprestressed).

1926.5.1 The reinforcement of footings and other principal structural members in which the concrete is deposited against the ground shall have not less than 3 inches (76 mm) of concrete between it and the ground contact surface. If the concrete surfaces after removal of the forms are to be exposed to the weather or be in contact with the ground, the reinforcement shall be protected with not less than 2 inches (51 mm) of concrete for bars larger than No. 5 and $1^1/_2$ inches (38 mm) for No. 5 bars or smaller except as set forth in Section 1926.5.5.

1926.5.2 The concrete protective covering for reinforcement at surfaces not exposed directly to the ground or weather shall be not less than $^3/_4$ inch (19 mm) for slabs and wall; and not less than $1^1/_2$ inches (38 mm) for beams, girders and columns. In concrete ribbed floors in which the clear distance between ribs is not more than 30 inches (762 mm), the protection of reinforcement shall be at least $^3/_4$ inch (19 mm).

1926.5.3 Concrete protection for reinforcement shall in all cases be as least equal to the diameter of bars except for concrete slabs and joists as set forth herein.

1926.5.4 Exposed reinforcement bars intended for bonding with future extensions shall be protected from corrosion by concrete or other adequate covering.

1926.5.5 For exterior balcony slabs, slab surface shall be sloped $^1/_8$ unit in 12 units or greater to safeguard against ponding of water and slabs shall be designed and constructed in accordance with the provisions of ACI 318.

1926.5.6 Concrete cover for cast-in-place, precast and prestressed concrete shall be in accordance with ACI 318 if not otherwise specified in this section. When this code requires a thickness of cover for fire protection greater than the minimum concrete specified in ACI 318, the greater thickness shall be used.

1926.5.7 Exposed reinforcement, inserts and plates intended for bonding with future extensions shall be protected from corrosion.

SECTION 1927
HIGH-VELOCITY HURRICANE ZONES—PRECAST CONCRETE UNITS

1927.1 General.

1927.1.1 Precast concrete units shall comply with the minimum requirements set forth in this section, and the standard set forth in Section 1920.3.

1927.1.2 All precast concrete elements and their attachments (including imbedments) to the main structural frame shall be designed by, and bear the seal of a Florida-registered architect or a Florida-registered engineer, which architect or engineer shall be proficient in structural design. The design shall be based on rational analysis for loads set forth in Chapter 16 (High-Velocity Hurricane Zones). The architect/engineer of record may delegate this responsibility to a Florida-registered delegated engineer. In that case, shop drawings and design calculations prepared by such delegated engineer shall be reviewed and approved by the architect and the engineer of record.

1927.1.3 Only the material cast monolithically with the units at the time of manufacture shall be used in computing stresses unless adequate and approved shear transfer is provided.

1927.1.4 The building official may promulgate and set forth in writing such reasonable rules for requiring tests to be made by an approved laboratory as he may consider necessary to insure compliance with this code or uniformity of the products produced. The quantity of tests shall be based on consideration of safety or volume of output.

1927.1.5 The building official or his or her representative shall have free access to the plant of any producer at all hours of normal operation, and failure to permit such access shall be cause for revocation of approval.

1927.1.6 Failure of any product to satisfy in every respect the quality prescribed, or failure to conform with plans and specifications, shall be cause for rejection of the products.

1927.2 Statements of responsibilities of architects and professional engineers on design of structures using precast concrete components.

1927.2.1 The structural construction documents shall indicate the configuration of precast components and shall include details of supports, anchors and connections for those components. Permit documents shall include sufficient details describing the attachment of precast units (including imbedments) to the main structure.

1927.2.2 The precast permit documents shall bear the signature and seal of the professional architect or engineer charged with the responsibility of the design of the precast units. The architect or engineer of record may delegate this responsibility to a Florida-registered delegated engineer. In that case, shop drawings and design calculations prepared by such delegated engineer shall be reviewed and approved by the architect and/or the engineer of record as an indication that his or her intent has been understood and that the specified criteria have been used.

1927.2.3 The structural submittals shall include component details, calculations and fabrication and erection drawings. All such submittals shall identify the specific project.

1927.3 Aggregate. The maximum size of the aggregate for precast units shall be not larger than one-third of the narrowest dimension between sides of the forms of the member in which the unit is cast nor larger than three-fourths of the minimum clear spacing between reinforcing bars and sides of the forms, except that where concrete is placed by means of high frequency vibration, the maximum size of the aggregate shall not be larger than one-half of the narrowest dimension between sides of the form.

1927.4 Strength of concrete.

1927.4.1 Concrete for precast structural units made of crushed stone or other heavy aggregate shall have a compressive strength of not less than 2,500 psi (17 238 kPa) at 28 days.

1927.4.2 Concrete for precast units made of light weight aggregate concrete shall follow the general provisions of Section 1923.1.2 with consideration of the nature and limitations of the aggregate and the strength of the product.

1927.5 Workmanship.

1927.5.1 The mix, the gradation of the aggregate and the workability shall be such as to insure complete filling of the form and continuous intimate bond between the concrete and all steel.

1927.5.2 Handling and conveying before curing shall be reduced to a minimum. Machinery for this purpose should be so designed that the unit will not be subject to bending or shock which would produce incipient cracks or broken edges or corners. Precast units shall not be freely transported or placed until the concrete is at least 14 days old, if made with regular cement, or at least seven days old, if made with Type III cement, or until its strength, as established by definite tests, is at least 60 percent of the required 28-day strength.

1927.5.3 The use of precast structural units not complying with ACI requirements or having visible cracks, honeycomb, exposed reinforcing except at ends or, with a compressive section dimension more than 1/8 inch (3.1 mm) less than specified dimension shall not be permitted.

1927.6 Curing.

1927.6.1 No precast structural unit shall be removed from the form until the concrete has attained a compressive strength of 50 percent of the 28-day design strength but not less than 1,250 psi (8619 kPa) as verified by representative tests.

1927.6.2 Curing by high pressure steam, steam vapor or other accepted processes may be employed to accelerate the hardening of the concrete and to reduce the time of curing.

1927.6.3 To ensure the eventual placement of the units in the structure without damage, the handling shall be done in such a manner that bending shall be reduced to a minimum or prevented.

1927.7 Identification and marking. All joists, beams, girders and other units shall show some mark plainly indicating the top of the unit. This mark or symbol shall indicate the manufacturer, the date of manufacture and the length, size and type of reinforcing.

1927.8 Cutting of holes. No openings or channels not provided for in the structural design shall be made on the job without the specific approval of the professional engineer in accordance with his or her written, detailed instructions covering such work.

1927.9 Anchorage. Anchorage of all precast concrete units shall be designed, based on rational analysis, to transmit loads and other forces to the structural frame.

1927.10 Bridging. Joists shall be secured against lateral displacement by cast-in-place bridging, and such bridging shall be spaced not to exceed 32 times the width of the compression flange of the joist except that for roof systems, cast-in-place portland-concrete slabs embedding the top flanges not less than 1/2 inch (12.7 mm), or steel inserts cast in the joist heads to which bulb-tees supporting gypsum decks are welded, shall be accepted in lieu of bridging.

1927.11 Connections. All joints and connections will perform their function at all stages of loading without overstress and with proper safety factors against failure caused by overload. Loading conditions to be considered in the design of joints and connections are service loads, including wind forces, volume changes resulting from shrinkage, creep, and temperature change, reaction loads, and loading encountered in stripping forms, shoring and removal of shores, storage and transportation of members.

1927.12 Inspections.

1927.12.1 All structural precast units shall be inspected for quality control by an architect or professional engineer qualified to perform these inspections prior to the concrete placement at the casting yard.

1927.12.2 All structural precast units and their attachments to the main structure shall be inspected after erection, but before concealment. Such inspections shall be performed by a Florida registered architect or professional engineer.

SECTION 1928
HIGH-VELOCITY HURRICANE ZONES — PRESTRESSED CONCRETE

1928.1 Prestressed concrete, as defined in Section 1921, shall comply with this section.

1928.1.1 All prestressed structural items shall be designed by a registered professional engineer. Openings or channels not provided for in the structural design shall not be made on the job without the specific approval of the design professional engineer.

1928.1.2 The building official may promulgate and set forth in writing such reasonable rules for requiring tests to be made by an approved laboratory as he or she may consider necessary to insure compliance with this code or uniformity of the products produced.

1928.1.3 The building official or his or her representative shall have free access to the plant of any producer at all hours of normal operation. Failure to permit such access shall be cause for revocation of approval.

1928.1.4 Failure of any product to satisfy the quality prescribed or failure to conform to plans and specifications shall be cause for rejection of the product.

1928.2 Statements of responsibilities of architects and professional engineers on design of cast-in-place post-tensioned concrete structural systems.

1928.2.1 The structural construction documents shall show the magnitude and location of all prestressing forces and all design assumptions.

1928.2.2 The structural engineer of record and/or the architect of record shall require the submission of calculations and installation drawings from a specialty engineer for post-tensioning systems for review by the structural engineer of record and/or the architect of record. Review is an indication that his or her intent has been understood and that the specified criteria have been used. The installation drawings shall provide full details of materials to be used including necessary accessories and instructions for construction and shall identify the specific project and shall bear the impressed seal, signature and date of the specialty engineer who prepared them.

1928.2.3 It is the responsibility of the structural engineer of record and/or the architect of record to review the post-tensioning system installation drawings so that the drawings are coordinated with the reinforcing steel shop drawings.

1928.2.4 Determining the effect of post-tensioning on other parts of the building is the responsibility of the structural engineer of record and/or the architect of record.

1928.3 Design and construction.

1928.3.1 Design and construction shall be in accordance with Chapter 18 of ACI 318.

1928.3.2 Calcium chloride shall not be used in concrete for prestressed members.

1928.4 Tendon and anchorage zones.

1928.4.1 Reinforcement shall be provided where required in tendon anchorage zones to resist bursting, splitting, and spalling forces induced by tendon anchorage. Regions of abrupt change in section shall be adequately reinforced.

1928.4.2 End blocks shall be provided where required for support bearing or for distribution of concentrated prestressing forces.

1928.4.3 Post-tensioning anchorage and supporting concrete shall be designed to resist maximum jacking force for strength of concrete at time of prestressing.

1928.4.4 Post-tensioning anchorage zones shall be designed to develop the guaranteed ultimate tensile strength of prestressing tendons using a strength reduction factor of 0.90 for concrete.

1928.5 Corrosion protection for unbonded prestressing tendons.

1928.5.1 Unbonded tendons shall be completely coated with suitable material to ensure corrosion protection.

1928.5.2 Tendon wrapping shall be continuous over the entire length to be unbonded, and shall prevent intrusion of cement paste or loss of coating materials during concrete placement.

1928.6 Post-tensioning ducts.

1928.6.1 Ducts for grouted or unbonded tendons shall be mortar-tight and nonreactive with concrete, tendons or filler material.

1928.6.2 Ducts for grouted single wire, strand or bar tendons shall have an inside diameter at least $^1/_4$ inch (6.3 mm) larger than tendon diameter.

1928.6.3 Ducts for grouted multiple wire, strand or bar tendons shall have an inside cross-sectional area at least two times the net area of the tendons.

1928.7 Grout for prestressing tendons.

1928.7.1 Grout shall consist of portland cement and water; or Portland cement, sand and water.

1928.7.2 Materials for grout shall conform as specified in ACI 318 and be as follows:

1. Portland cement.
2. Water content shall be minimum necessary for proper pumping of grout; however, water-cement ratio shall not exceed 0.45 by weight.
3. Sand, if used, shall conform to Standard Specifications for Aggregate for Masonry Mortar, ASTM C 144, except that gradation may be modified as necessary to obtain satisfactory workability.
4. Admixtures conforming to ACI 318 and known to have no injurious effects on grout, steel or concrete may be used. Calcium chloride shall not be used.
5. Water shall not be added to increase grout flowability that has been decreased by delayed use of grout.
6. Grout temperatures shall not be above 90ºF (32ºC) during mixing and pumping.

1928.8 Protection for prestressing tendons. Burning or welding operations in the vicinity of prestressing tendons shall be carefully performed, so that tendons are not subject to excessive temperatures, welding sparks or ground currents.

1928.9 Application and measurement of prestressing force.

1928.9.1 Prestressing force shall be determined by both of the following methods and the cause of any difference in force determination that exceeds 5 percent shall be ascertained and corrected.

1. Measurement of tendon elongation. Required elongation shall be determined from average load-elongation curves for prestressing tendons used.
2. Observation of jacking force on a calibrated gauge or load cell or by use of a calibrated dynamometer.

1928.9.2 Where transfer of force from bulkheads or pretensioning bed to concrete is accomplished by flame cutting prestressing tendons, cutting points and cutting sequence shall be predetermined to avoid undesired temporary stresses.

1928.9.3 Long lengths of exposed pretensioned strand shall be cut near the member to minimize shock to concrete.

1928.9.4 Total loss of prestress as a result of unreplaced broken tendons shall not exceed 2 percent of total prestress.

1928.10 Post-tensioning anchorages and couplers.

1928.10.1 Couplers shall be placed in areas approved by the professional engineer and enclosed in housing long enough to permit necessary movements.

1928.10.2 In unbonded construction subject to repetitive loads, special attention shall be given to the possibility of fatigue in anchorages and couplers.

1928.10.3 Anchorage and end fittings shall be permanently protected against corrosion.

SECTION 1929 HIGH-VELOCITY HURRICANE ZONES— PNEUMATICALLY PLACED CONCRETE (SHOTCRETE)

1929.1 General.

1929.1.1 Pneumatically placed concrete is a proportioned combination of fine aggregate portland cement and water which, after mixing, is pneumatically projected by air directly onto the surface to which it is to be applied.

1929.1.2 Pneumatically placed concrete shall conform to all requirements of Specifications for Materials, Proportioning and Application of Shotcrete, ACI 506.2 published by the American Concrete Institute, except as modified herein.

1929.1.3 Pneumatically placed concrete shall be composed of Portland cement, aggregate and water proportioned to produce a concrete suitable for pneumatic application.

1929.1.4 Concrete ingredients shall be selected and proportioned in a manner that will produce concrete which will be extremely strong, dense and resistant to weathering and abrasion.

1929.2 Sampling and testing cement and aggregate. The contractor shall determine the source, kind and quality of the cement and aggregates to be used in the work well in advance of the time scheduled for starting the work and when so directed by the building official shall submit such information for approval before starting shotcrete operation.

1929.3 Surface preparation. To insure adequate bond, the newly chipped and sandblasted surface shall be thoroughly moistened with water prior to application of shotcrete. In no instance shall shotcrete be applied in an area where free running water exists.

1929.4 Proportioning. Prior to the start of shotcreting, the contractor shall submit to the professional engineer the recommended mix as a ratio of cement to aggregate. The recommended mix shall be on the basis of test data from prior experience.

1929.5 Mixing.

1929.5.1 Shotcrete shall be thoroughly mixed by machine and then passed through a sieve to remove all large particles before placing in the hopper of the cement gun. The mixture shall not be permitted to become damp. Each batch should be entirely discharged before recharging is begun. The mixer should be cleaned thoroughly enough to remove all adherent materials from the mixing vanes and from the drum at regular intervals.

1929.5.2 Water in any amount shall not be added to the mix before it enters the cement gun. Quantities of water shall be controlled by a valve at the nozzle of the gun. Water content shall be adjusted as required for proper placement, but shall in no case exceed 4 gallons (15 L) of water per sack of cement, including the water contained in the aggregate.

1929.5.3 Remixing or tempering shall not be permitted. Mixed material that has stood 45 minutes without being used shall be discarded. Rebound materials shall not be reused.

1929.6 Application.

1929.6.1 In shooting walls and columns, application shall begin at the bottom and the first coat shall completely embed the reinforcement to the form.

1929.6.2 In shooting beams, application shall begin at the bottom and a surface at right angles to the nozzle shall be maintained.

1929.6.3 In shooting slabs, the nozzle shall be held at a slight angle to the work so that rebound is blown on to the finished portion where it shall be removed.

1929.6.4 Corners shall be filled first. "Shooting" shall be from an angle as near perpendicular to the surface as practicable, with the nozzle held approximately 3 feet (915 mm) from the work, except in confined control. If the flow of material at the nozzle is not uniform and slugs, sand spots or wet sloughs result, the nozzle person shall direct the nozzle away from the work until the faulty conditions are corrected. Such defects shall be replaced as the work progresses.

1929.6.5 Shotcreting shall be suspended if:

1. Air velocity separates the cement from the sand at the nozzle.
2. Temperature approaches freezing and the newly placed shotcrete cannot be protected.

1929.6.6 The time interval between successive layers in sloping, vertical or overhanging work must be sufficient to allow initial but not final set to develop. At the time the initial set is developing, the surface shall be cleaned to remove the thin film of laitance in order to provide a good bond with succeeding applications.

1929.7 Construction joints. Construction joints or day's work joints shall be sloped off to a thin, clean, regular edge, preferably at a 45 degree (0.78 rad) slope. Before placing the adjoining work, the slope portion and adjacent shotcrete shall be thoroughly cleaned as necessary, then moistened and scoured with an air jet.

1929.8 Curing and protection.

1929.8.1 Curing shall be in accordance with ACI 506.2 depending upon atmospheric condition.

1929.8.2 Immediately after placement, shotcrete shall be maintained in a moist condition for at least the first 24 hours.

1929.8.3 Final curing shall continue for seven days after placement if Type I Portland cement is used, or for three days if high-early-strength Type III Portland cement is used, or until the specified strength is attained. Final curing may consist of the initial curing process or an approved moisture-retaining covering.

1929.8.4 Natural curing may be used when relative humidity remains above 85 percent when approved by the professional engineer of record.

CHAPTER 20
ALUMINUM

SECTION 2001 GENERAL

2001.1 Scope. Provisions of this chapter shall govern the quality, design, fabrication and erection of aluminum alloys used in building construction.

Exception: Buildings and structures located within the high-velocity hurricane zone shall comply with the provisions of Section 2003.

SECTION 2002 MATERIALS

2002.1 General. The quality, design, fabrication and erection of aluminum used structurally in buildings or structures shall conform to good engineering practice, the provisions of this chapter and other applicable requirements of this code.

Exception: All buildings located within the high-velocity hurricane zone shall comply with the requirements of Section 2003.

2002.2 Structural aluminum construction. The design, fabrication and assembly of structural aluminum for buildings or structures shall conform to AA ASM 35 and Specifications for Aluminum Structures, Aluminum Design Manual, Part 1-A and 1-B, of the Aluminum Association. The use of aluminum alloys not listed in the manual shall be permitted provided their standard of performance is not less than those required in the manual and the performance is substantiated to the satisfaction of the building official.

2002.2.1 Definitions

PRIMARY MEMBER. Structural framing members providing structural support to other members and/or surfaces of a structure including, but not limited to beams, posts, columns, joists, structural gutters, headers, eave rail, purlins, roof brace.

SECONDARY MEMBERS. Structural framing members which do not provide basic support for the entire structure, generally including, but not limited to, such members as kickplate rails, chair rails, roof or wall panels, wall brace.

STRUCTURAL MEMBERS. Members or sections that provide support to an assembly and/or resist applied loads.

2002.3 Screen enclosures.

2002.3.1 Actual wall thickness of extruded aluminum members shall be not less than 0.040 inch (1 mm).

2002.3.2 Reserved.

2002.3.3 Vinyl and acrylic panels shall be removable. Removable panels shall be identified as removable by a decal. The identification decal shall essentially state "Removable panel SHALL be removed when wind speeds exceed 75 mph (34 m/s)." Decals shall be placed such that the decal is visible when the panel is installed.

2002.4 Loads. Structural members supporting screened enclosures shall be designed for wind in either of two orthogonal directions using the pressures given in Table 2002.4. Each primary member shall also be designed for a 300 pound (1.33 kN) load applied vertically downward along any 1 foot (305 Mm) of any member, not occurring simultaneously with wind load.

2002.4.1 The following design guides shall be accepted as conforming to accepted engineering practices:

AAF Guide to Aluminum Construction in High Wind Areas.

2002.5 Wall panels. The minimum thickness for formed sheet aluminum structural wall panels shall be not less than 0.024 inch (0.6 mm), subject to approved tolerances.

2002.6 Sunrooms. Sunrooms shall comply with AAMA/NPEA/NSA 2100 with the structural requirements and testing provisions of Chapter 5 modified to incorporate ASCE 7. Sunrooms shall be categorized in one of the following categories.

Category I: A roof or a covering of an outdoor space. The openings shall be permitted to be enclosed with insect screening or 0.5 mm (20 mil) maximum thickness plastic film. The space is defined as nonhabitable and unconditioned.

Category II: A roof or a covering of an outdoor space with enclosed walls. The openings are permitted to be enclosed with translucent or transparent plastic or glass. The space is defined as nonhabitable and unconditioned.

Category III: A roof or a covering of an outdoor space with enclosed walls. The openings are permitted to be enclosed with translucent or transparent plastic or glass. The sunroom complies with additional requirements for forced-entry resistance, air-leakage resistance and water-penetration resistance. The space is defined as nonhabitable and unconditioned.

Category IV: A roof or a covering of an outdoor space with enclosed walls. The sunroom is designed to be heated and/or cooled by a separate temperature control or system and is thermally isolated from the primary structure. The sunroom complies with additional requirements for forced-entry resistance, water-penetration resistance, air-leakage resistance, and thermal performance. The space is defined as habitable and conditioned.

Category V: A roof or a covering of an outdoor space with enclosed walls. The sunroom is designed to be heated and/or cooled and is open to the main structure. The sunroom complies with additional requirements for forced-entry resistance, water-penetration resistance, air-leakage resistance, and thermal performance. The space is defined as habitable and conditioned.

TABLE 2002.4
DESIGN WIND PRESSURES FOR ALUMINUM SCREENED ENCLOSURES[a,b,c]

SURFACE	BASIC WIND SPEED (mph)											
	100		110		120		130		140		150	
	Exposure Category (B or C) Design Pressure (psf)											
	B	C	B	C	B	C	B	C	B	C	B	C
Horizontal Pressure on Windward Surfaces	12	17	13	18	15	21	18	25	21	29	24	33
Horizontal Pressure on Leeward Surfaces	10	13	10	14	13	17	14	19	15	23	18	27
Vertical Pressure - Screen Surfaces	3	5	4	5	4	6	5	7	6	8	7	9
Vertical Pressure - Solid Surfaces	10	14	11	15	13	18	15	21	17	24	20	28

For SI: 1 pound per square foot = 9.479 kN/m^2.

NOTES:

a. Pressures include importance factors determined in accordance with Table 1604.5.
b. Pressures apply to enclosures with a mean enclosure roof height of 30 feet (10 m). For other heights, multiply the pressures in this table by the factors in Table 2002.4A.
c. Apply horizontal pressures to the area of the enclosure projected on a vertical plane normal to the assumed wind direction, simultaneously inward on the windward side and outward on the leeward side.
d. Apply vertical pressures upward and downward to the area of the enclosure projected on a horizontal plane.
e. Apply horizontal pressures simultaneously with vertical pressures.
f. Table pressures are MWFRS Loads. The design of solid roof panels and their attachments shall be based on component and cladding loads for enclosed or partially enclosed structures as appropriate.
g. Table pressures apply for all screen densities up to 20×20×.013” mesh. For greater densities use pressures for enclosed buildings.
h. Table pressures may be interpolated using ASCE 7 methodology.

SECTION 2003
HIGH-VELOCITY HURRICANE ZONES—ALUMINUM

2003.1 Design. Aluminum members shall be designed by methods admitting of rational analysis according to established principles of mechanics.

2003.2 Standards. The design, fabrication, and erection of structural aluminum shall conform to the Aluminum Design Manual.

2003.3 Workmanship. Aluminum construction shall be in conformance with the tolerances, quality and methods of construction as set forth in Section 2003.2 and the American Welding Society’s Structural Welding Code-Aluminum (D1.2).

2003.4 Definitions. Members shall be defined as in Section 2002.2.1.

2003.5 Identification. Aluminum for structural elements shall at all times be segregated or otherwise handled in the fabricator’s plant so that the separate alloys and tempers are positively identified and, after completion of fabrication, shall be marked to identify the alloy and temper. Such markings shall be affixed to complete members and assemblies or to boxed or bundled shipments of multiple units prior to shipment from the fabricator’s plant.

Exception: Certification by the fabricator and or contractor shall be provided attesting to the alloy and temper of the material.

TABLE 2002.4A
HEIGHT ADJUSTMENT FACTORS

MEAN ROOF HEIGHT	EXPOSURE	
	B	C
15	1	0.86
20	1	0.92
25	1	0.96
30	1	1.00
35	1.05	1.03
40	1.09	1.06
45	1.12	1.09
50	1.16	1.11
55	1.19	1.14
60	1.22	1.16

2003.6 Allowable unit stresses.

2003.6.1 The design, fabrication and assembly of aluminum members for building and other structures shall conform to the standard set forth in Section 2003.2 and as otherwise set forth herein.

2003.6.2 The use of aluminum alloys, other than those listed in the standard shall provide performance not less than those required by the standard and as set forth herein.

2003.6.3 Aluminum members shall be limited by the deflections set forth in Section 1613.

2003.7 The building official may require that any structure using aluminum primary or secondary members be designed by a Florida-registered professional engineer.

2003.7.1 Reserved.

2003.7.2 In addition to flexural and shearing stresses, the critical factors of buckling, fatigue, stress raisers such as notches or holes or shape re-entrant corners, deflection and connections shall be considered and provided for by proper design.

2003.7.3 All solid roof systems shall be designed for a minimum 30 psf (1436 Pa) live load.

2003.7.4 All buildings and structures shall be designed to resist uplift. In the case of placement on existing slabs and foundations, sufficient information and calculations shall be provided by the professional engineer and/or architect to verify the ability of the slab or foundation to resist uplift loads.

2003.7.5 All connection devices shall be rated by load testing by an approved testing laboratory.

2003.7.5.1 All expansion anchors shall not be installed less than 3 inches (76 mm) from the edge of concrete slab and/or footings. All expansion anchors shall develop an ultimate withdrawal resisting force equal to four times the imposed load, with no stress increase for duration of load.

2003.8 Fabrication and construction details.

2003.8.1 Connections. Aluminum members shall be designed as set forth in the standards in Section 2003.2.

2003.8.1.1 Fasteners. Bolts and other fasteners shall be aluminum, stainless steel, hot-dip or electro-galvanized steel. Double cadmium plated steel bolts may also be used.

2003.8.1.2 Painting. Except as prescribed in Section 2003.8.4, painting or coating of aluminum alloy parts shall be required only when called for on the plans.

2003.8.1.3 Welding. Aluminum parts shall be welded with an inert-gas-shielded arc or resistance welding process. No welding process that requires a welding flux shall be used. Filler alloys complying with the requirements of the standard in this chapter shall be used.

2003.8.1.4 Welder qualifications. All welding of structural aluminum member shall be performed by certified welders.

2003.8.1.5 Erection. During erection, structural aluminum shall be adequately braced and fastened to resist dead, wind and erection loads.

2003.8.2 Structural aluminum decking and siding.

2003.8.2.1 Aluminum sections spanning between supports shall be limited in span to satisfactorily support the positive and negative loads set forth in Chapter 16 (High-Velocity Hurricane Zones). The deflection of decking shall not exceed that set forth in Section 1613.

2003.8.2.2 Aluminum sheet used for roof decking or siding shall be not less than 0.032 inch (0.8 mm) in thickness.

2003.8.2.3 Aluminum sheets shall be secured to the supports to adequately resist positive and negative loads. Attachments shall be at intervals not exceeding 8 inches (203 mm) o.c. and shall be secured to each other at side laps at intervals as required by rational analysis and/or tests, but shall not exceed 12 inches (305 mm) o.c.

2003.8.2.4 Fasteners shall have a head, and/or be provided with washers not less than $^1/_2$ inch (13 mm) in diameter.

2003.8.2.5 Fasteners located at end laps shall be placed not more than 2 inches (51 mm) nor less than 1 inch (25 mm) from the end of overlapping sheets.

2003.8.2.6 Where roof or wall cladding is of aluminum, an approved membrane to protect against water intrusion to the interior shall be provided or the aluminum cladding shall be designed and constructed with an approved continuous edge-interlock, overlap or seam to prevent water intrusion.

2003.8.3 Nonstructural aluminum decking and siding.

2003.8.3.1 Nonstructural aluminum sheets shall be backed with cladding as set forth in Chapter 23 and Chapter 24 (High-Velocity Hurricane Zones).

2003.8.3.2 Nonstructural aluminum sheets shall have a minimum thickness of 0.032 inches (0.8 mm).

2003.8.3.3 An approved membrane to protect against water intrusion shall be provided or the aluminum cladding shall be designed and constructed with an approved continuous edge-interlock, overlap or seam to prevent water intrusion.

2003.8.3.4 Nonstructural decking and siding shall be attached as set forth in Section 2003.8.2 except that the attachment of aluminum residential siding shall be by rational analysis and/or tests using a minimum 0.120-inch (3 mm) diameter aluminum nails of sufficient length to penetrate studs a minimum of 2 inches (51 mm). Nails at wood studs shall be as required by rational analysis and/or tests, but spaced not greater than 24 inches (610 mm) o.c. horizontally and no greater than 8 inches (203 mm) o.c. vertically.

2003.8.4 Dissimilar materials.

2003.8.4.1 Aluminum may contact compatible metals such as, but not limited to:

1. Nonmagnetic stainless steel provided the contacting surfaces and any attachments are enclosed for protection from the weather.
2. Zinc.
3. White bronze.

2003.8.4.2 Aluminum contacting metals not considered compatible shall be protected as follows:

1. Painting the dissimilar metal with a prime coat of zinc-chromate primer or other suitable primer, followed by one or two coats of aluminum metal-and-masonry paint or other suitable protective coating, excluding those containing lead pigmentation.
2. Painting the dissimilar metal with a coating of a heavy-bodied bituminous paint.
3. Placing a good quality caulking material between the aluminum and the dissimilar metal.
4. Applying a nonabsorptive tape or gasket.
5. Hot-dip galvanizing or zinc-plating steel members after fabrication.

2003.8.4.3 Dissimilar metals shall be painted if used in locations where drainage from them passes over aluminum.

2003.8.4.4 Aluminum surfaces in contact with lime-mortar, concrete, or other masonry materials, shall be protected with alkali-resistant coatings, such as heavy-bodied bituminous paint or water-white methacrylate lacquer.

2003.8.4.5 Aluminum in contact with wood or other absorbing materials which may become repeatedly wet shall be painted with two coats of aluminum metal-and-masonry paint or a coat of heavy-bodied bituminous paint, or the wood or other absorbing material shall be painted with two coats of aluminum house paint and the joints sealed with a good quality caulking compound.

2003.8.4.6 Where aluminum is in contact with treated wood, wood shall be treated with pentachlorophenol, 5 percent minimum concentration, creosote, or zinc naphthanate, following the protective measures outlined in Section 2003.8.4.5.

2003.8.5 Expansion and contraction. Aluminum work shall be designed and anchored so the work will not be distorted nor the fasteners overstressed from the expansion and contraction of the metal.

CHAPTER 21
MASONRY

SECTION 2101
GENERAL

2101.1 Scope. This chapter shall govern the materials, design, construction and quality of masonry.

Exception: Buildings and structures located within the high-velocity hurricane zone shall comply with the provisions of Section 2114 and Sections 2118 through 2122.

2101.2 Design methods. Masonry shall comply with the provisions of one of the following design methods in this chapter as well as the requirements of Sections 2101 through 2104. Masonry designed by the allowable stress design provisions of Section 2101.2.1, the strength design provisions of Section 2101.2.2 or the prestressed masonry provisions of Section 2101.2.3 shall comply with Section 2105.

2101.2.1 Allowable stress design. Masonry designed by the allowable stress design method shall comply with the provisions of Section 2107.

2101.2.2 Strength design. Masonry designed by the strength design method shall comply with the provisions of Section 2108, except that autoclaved aerated concrete (AAC) masonry shall comply with the provisions of Chapter 1 and Appendix A of ACI 530/ASCE 5/TMS 402.

2101.2.3 Prestressed masonry. Prestressed masonry shall be designed in accordance with Chapters 1 and 4 of ACI 530/ASCE 5/TMS 402.

2101.2.4 Empirical design. Masonry designed by the empirical design method shall comply with the provisions of Section 2109 or Chapter 5 of ACI 530/ASCE 5/TMS 402.

2101.2.5 Glass unit masonry. Glass unit masonry shall comply with the provisions of Section 2110 or Chapter 7 of ACI 530/ASCE 5/ TMS 402.

2101.2.6 Masonry veneer. Masonry veneer shall comply with the provisions of Chapter 14 or Chapter 6 of ACI 530/ASCE 5/TMS 402.

2101.2.7 Prescriptive methods. Masonry construction is permitted in accordance with applicable standards referenced in Section 1609.1.1.

2101.3 Construction documents. The construction documents shall show all of the items required by this code including the following:

1. Specified size, grade, type and location of reinforcement, anchors and wall ties.
2. Reinforcing bars to be welded and welding procedure.
3. Size and location of structural elements.
4. Provisions for dimensional changes resulting from elastic deformation, creep, shrinkage, temperature and moisture.

2101.3.1 Fireplace drawings. The construction documents shall describe in sufficient detail the location, size and construction of masonry fireplaces. The thickness and characteristics of materials and the clearances from walls, partitions and ceilings shall be clearly indicated.

SECTION 2102
DEFINITIONS AND NOTATIONS

2102.1 General. The following words and terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meanings shown herein.

AAC MASONRY. Masonry made of autoclaved aerated concrete (AAC) units, manufactured without internal reinforcement and bonded together using thin- or thick-bed mortar.

ADOBE CONSTRUCTION. Construction in which the exterior load-bearing and nonload-bearing walls and partitions are of unfired clay masonry units, and floors, roofs and interior framing are wholly or partly of wood or other approved materials.

Adobe, stabilized. Unfired clay masonry units to which admixtures, such as emulsified asphalt, are added during the manufacturing process to limit the units' water absorption so as to increase their durability.

Adobe, unstabilized. Unfired clay masonry units that do not meet the definition of "Adobe, stabilized."

ANCHOR. Metal rod, wire or strap that secures masonry to its structural support.

ARCHITECTURAL TERRA COTTA. Plain or ornamental hard-burned modified clay units, larger in size than brick, with glazed or unglazed ceramic finish.

AREA.

Bedded. The area of the surface of a masonry unit that is in contact with mortar in the plane of the joint.

Gross cross-sectional. The area delineated by the out-to-out specified dimensions of masonry in the plane under consideration.

Net cross-sectional. The area of masonry units, grout and mortar crossed by the plane under consideration based on out-to-out specified dimensions.

AUTOCLAVED AERATED CONCRETE (AAC). Low-density cementitious product of calcium silicate hydrates, whose material specifications are defined in ASTM C 1386.

BED JOINT. The horizontal layer of mortar on which a masonry unit is laid.

BOND BEAM. A horizontal grouted element within masonry in which reinforcement is embedded.

BOND REINFORCING. The adhesion between steel reinforcement and mortar or grout.

BRICK.

Calcium silicate (sand lime brick). A masonry unit made of sand and lime.

Clay or shale. A masonry unit made of clay or shale, usually formed into a rectangular prism while in the plastic state and burned or fired in a kiln.

Concrete. A masonry unit having the approximate shape of a rectangular prism and composed of inert aggregate particles embedded in a hardened cementitious matrix.

BUTTRESS. A projecting part of a masonry wall built integrally therewith to provide lateral stability.

CAST STONE. A building stone manufactured from portland cement concrete precast and used as a trim, veneer or facing on or in buildings or structures.

CELL. A void space having a gross cross-sectional area greater than $1^1/_2$ square inches (967 mm^2).

CHIMNEY. A primarily vertical enclosure containing one or more passageways for conveying flue gases to the outside atmosphere.

CHIMNEY TYPES.

High-heat appliance type. An approved chimney for removing the products of combustion from fuel-burning, high-heat appliances producing combustion gases in excess of 2,000°F (1093°C) measured at the appliance flue outlet (see Section 2113.11.3).

Low-heat appliance type. An approved chimney for removing the products of combustion from fuel-burning, low-heat appliances producing combustion gases not in excess of 1,000°F (538°C) under normal operating conditions, but capable of producing combustion gases of 1,400°F (760°C) during intermittent forces firing for periods up to 1 hour. Temperatures shall be measured at the appliance flue outlet.

Masonry type. A field-constructed chimney of solid masonry units or stones.

Medium-heat appliance type. An approved chimney for removing the products of combustion from fuel-burning, medium-heat appliances producing combustion gases not exceeding 2,000°F (1093°C) measured at the appliance flue outlet (see Section 2113.11.2).

CLEANOUT. An opening to the bottom of a grout space of sufficient size and spacing to allow the removal of debris.

COLLAR JOINT. Vertical longitudinal joint between wythes of masonry or between masonry and backup construction that is permitted to be filled with mortar or grout.

COLUMN, MASONRY. An isolated vertical member whose horizontal dimension measured at right angles to its thickness does not exceed three times its thickness and whose height is at least four times its thickness.

COMPOSITE ACTION. Transfer of stress between components of a member designed so that in resisting loads, the combined components act together as a single member.

COMPOSITE MASONRY. Multiwythe masonry members acting with composite action.

COMPRESSIVE STRENGTH OF MASONRY. Maximum compressive force resisted per unit of net cross-sectional area of masonry, determined by the testing of masonry prisms or a function of individual masonry units, mortar and grout.

CONNECTOR. A mechanical device for securing two or more pieces, parts or members together, including anchors, wall ties and fasteners.

COVER. Distance between surface of reinforcing bar and edge of member.

DIAPHRAGM. A roof or floor system designed to transmit lateral forces to shear walls or other lateral-load-resisting elements.

DIMENSIONS.

Actual. The measured dimension of a masonry unit or element.

Nominal. The specified dimension plus an allowance for the joints with which the units are to be laid. Thickness is given first, followed by height and then length.

Specified. The dimensions specified for the manufacture or construction of masonry, masonry units, joints or any other component of a structure.

EFFECTIVE HEIGHT. For braced members, the effective height is the clear height between lateral supports and is used for calculating the slenderness ratio. The effective height for unbraced members is calculated in accordance with engineering mechanics.

FIREPLACE. A hearth and fire chamber or similar prepared place in which a fire may be made and which is built in conjunction with a chimney.

FIREPLACE THROAT. The opening between the top of the firebox and the smoke chamber.

FOUNDATION PIER. An isolated vertical foundation member whose horizontal dimension measured at right angles to its thickness does not exceed three times its thickness and whose height is equal to or less than four times its thickness.

GLASS UNIT MASONRY. Masonry composed of glass units bonded by mortar.

GROUTED MASONRY.

Grouted hollow-unit masonry. That form of grouted masonry construction in which certain designated cells of hollow units are continuously filled with grout.

Grouted multiwythe masonry. That form of grouted masonry construction in which the space between the wythes is solidly or periodically filled with grout.

HEAD JOINT. Vertical mortar joint placed between masonry units within the wythe at the time the masonry units are laid.

HEADER (Bonder). A masonry unit that connects two or more adjacent wythes of masonry.

HEIGHT, WALLS. The vertical distance from the foundation wall or other immediate support of such wall to the top of the wall.

MASONRY. A built-up construction or combination of building units or materials of clay, shale, concrete, glass, gypsum, stone or other approved units bonded together with or without mortar or grout or other accepted methods of joining.

Ashlar masonry. Masonry composed of various-sized rectangular units having sawed, dressed or squared bed surfaces, properly bonded and laid in mortar.

Coursed ashlar. Ashlar masonry laid in courses of stone of equal height for each course, although different courses shall be permitted to be of varying height.

Glass unit masonry. Masonry composed of glass units bonded by mortar.

Plain masonry. Masonry in which the tensile resistance of the masonry is taken into consideration and the effects of stresses in reinforcement are neglected.

Random ashlar. Ashlar masonry laid in courses of stone set without continuous joints and laid up without drawn patterns. When composed of material cut into modular heights, discontinuous but aligned horizontal joints are discernible.

Reinforced masonry. Masonry construction in which reinforcement acting in conjunction with the masonry is used to resist forces.

Solid masonry. Masonry consisting of solid masonry units laid contiguously with the joints between the units filled with mortar.

Unreinforced (plain) masonry. Masonry in which the tensile resistance of masonry is taken into consideration and the resistance of the reinforcing steel, if present, is neglected.

MASONRY UNIT. Brick, tile, stone, glass block or concrete block conforming to the requirements specified in Section 2103.

Clay. A building unit larger in size than a brick, composed of burned clay, shale, fired clay or mixtures thereof.

Concrete. A building unit or block larger in size than 12 inches by 4 inches by 4 inches (305 mm by 102 mm by 102 mm) made of cement and suitable aggregates.

Hollow. A masonry unit whose net cross-sectional area in any plane parallel to the load-bearing surface is less than 75 percent of its gross cross-sectional area measured in the same plane.

Solid. A masonry unit whose net cross-sectional area in every plane parallel to the load-bearing surface is 75 percent or more of its gross cross-sectional area measured in the same plane.

MEAN DAILY TEMPERATURE. The average daily temperature of temperature extremes predicted by a local weather bureau for the next 24 hours.

MORTAR. A plastic mixture of approved cementitious materials, fine aggregates and water used to bond masonry or other structural units.

MORTAR, SURFACE-BONDING. A mixture to bond concrete masonry units that contains hydraulic cement, glass fiber reinforcement with or without inorganic fillers or organic modifiers and water.

PLASTIC HINGE. Reserved.

PRESTRESSED MASONRY. Masonry in which internal stresses have been introduced to counteract potential tensile stresses in masonry resulting from applied loads.

PRISM. An assemblage of masonry units and mortar with or without grout used as a test specimen for determining properties of the masonry.

RUBBLE MASONRY. Masonry composed of roughly shaped stones.

Coursed rubble. Masonry composed of roughly shaped stones fitting approximately on level beds and well bonded.

Random rubble. Masonry composed of roughly shaped stones laid without regularity of coursing but well bonded and fitted together to form well-divided joints.

Rough or ordinary rubble. Masonry composed of unsquared field stones laid without regularity of coursing but well bonded.

RUNNING BOND. The placement of masonry units such that head joints in successive courses are horizontally offset at least one-quarter the unit length.

SHEAR WALL. A wall designed to resist lateral forces parallel to the plane of the wall.

Detailed plain masonry shear wall. Reserved.

Intermediate prestressed masonry shear wall. Reserved.

Intermediate reinforced masonry shear wall. Reserved.

Ordinary plain masonry shear wall. Reserved.

Ordinary plain prestressed masonry shear wall. Reserved.

Ordinary reinforced masonry shear wall. Reserved.

Special prestressed masonry shear wall. Reserved.

Special reinforced masonry shear wall. Reserved.

SHELL. The outer portion of a hollow masonry unit as placed in masonry.

SPECIFIED. Required by construction documents.

SPECIFIED COMPRESSIVE STRENGTH OF MASONRY, f'_m. Minimum compressive strength, expressed as force per unit of net cross-sectional area, required of the masonry used in construction by the construction documents, and upon which the project design is based. Whenever the quantity f'_m is under the radical sign, the square root of numerical value only is intended and the result has units of pounds per square inch (psi) (MPa).

STACK BOND. The placement of masonry units in a bond pattern is such that head joints in successive courses are vertically aligned. For the purpose of this code, requirements for stack bond shall apply to masonry laid in other than running bond.

STONE MASONRY. Masonry composed of field, quarried or cast stone units bonded by mortar.

Ashlar stone masonry. Stone masonry composed of rectangular units having sawed, dressed or squared bed surfaces and bonded by mortar.

Rubble stone masonry. Stone masonry composed of irregular-shaped units bonded by mortar.

STRENGTH.

Design strength. Nominal strength multiplied by a strength reduction factor.

Nominal strength. Strength of a member or cross section calculated in accordance with these provisions before application of any strength-reduction factors.

Required strength. Strength of a member or cross section required to resist factored loads.

THIN-BED MORTAR. Mortar for use in construction of AAC unit masonry with joints 0.06 inch (1.5 mm) or less.

TIE, LATERAL. Loop of reinforcing bar or wire enclosing longitudinal reinforcement.

TIE, WALL. A connector that connects wythes of masonry walls together.

TILE. A ceramic surface unit, usually relatively thin in relation to facial area, made from clay or a mixture of clay or other ceramic materials, called the body of the tile, having either a "glazed" or "unglazed" face and fired above red heat in the course of manufacture to a temperature sufficiently high enough to produce specific physical properties and characteristics.

TILE, STRUCTURAL CLAY. A hollow masonry unit composed of burned clay, shale, fire clay or mixture thereof, and having parallel cells.

WALL. A vertical element with a horizontal length-to-thickness ratio greater than three, used to enclose space.

Cavity wall. A wall built of masonry units or of concrete, or a combination of these materials, arranged to provide an airspace within the wall, and in which the inner and outer parts of the wall are tied together with metal ties.

Composite wall. A wall built of a combination of two or more masonry units bonded together, one forming the backup and the other forming the facing elements.

Dry-stacked, surface-bonded walls. A wall built of concrete masonry units where the units are stacked dry, without mortar on the bed or head joints, and where both sides of the wall are coated with a surface-bonding mortar.

Masonry-bonded hollow wall. A wall built of masonry units so arranged as to provide an airspace within the wall, and in which the facing and backing of the wall are bonded together with masonry units.

Parapet wall. The part of any wall entirely above the roof line.

WEB. An interior solid portion of a hollow masonry unit as placed in masonry.

WYTHE. Each continuous, vertical section of a wall, one masonry unit in thickness.

NOTATIONS.

A_n = Net cross-sectional area of masonry, square inches (mm^2).

b = Effective width of rectangular member or width of flange for T and I sections, inches (mm).

d_b = Diameter of reinforcement, inches (mm).

F_s = Allowable tensile or compressive stress in reinforcement, psi (MPa).

f_r = Modulus of rupture, psi (MPa).

f_y = Specified yield stress of the reinforcement or the anchor bolt, psi (MPa).

f'_{AAC} = Specified compressive strength of AAC masonry, the minimum compressive strength for a class of AAC masonry as specified in ASTM C 1386, psi (MPa).

f'_m = Specified compressive strength of masonry at age of 28 days, psi (MPa).

f'_{mi} = Specified compressive strength of masonry at the time of prestress transfer, psi (MPa).

K = The lesser of the masonry cover, clear spacing between adjacent reinforcement, or five times d_b, inches (mm).

L_s = Distance between supports, inches (mm).

L_w = Length of wall, inches (mm).

l_d = Required development length or lap length of reinforcement, inches (mm).

l_{de} = Embedment length of reinforcement, inches (mm).

P_w = Weight of wall tributary to section under consideration, pounds (N).

t = Specified wall thickness dimension or the least lateral dimension of a column, inches (mm).

V_n = Nominal shear strength, pounds (N).

V_u = Required shear strength due to factored loads, pounds (N).

W = Wind load, or related internal moments in forces.

γ = Reinforcement size factor.

ρ_n = Ratio of distributed shear reinforcement on plane perpendicular to plane of A_{mv}.

ρ_{max} = Maximum reinforcement ratio.

ϕ = Strength reduction factor.

SECTION 2103 MASONRY CONSTRUCTION MATERIALS

2103.1 Concrete masonry units. Concrete masonry units shall conform to the following standards: ASTM C 55 for concrete brick; ASTM C 73 for calcium silicate face brick; ASTM C 90 for load-bearing concrete masonry units or ASTM C 744 for prefaced concrete and calcium silicate masonry units.

2103.2 Clay or shale masonry units. Clay or shale masonry units shall conform to the following standards: ASTM C 34 for structural clay load-bearing wall tile; ASTM C 56 for structural clay nonload-bearing wall tile; ASTM C 62 for building brick (solid masonry units made from clay or shale); ASTM C 1088 for solid units of thin veneer brick; ASTM C 126 for ceramic-glazed structural clay facing tile, facing brick and solid masonry units; ASTM C 212 for structural clay facing tile; ASTM C 216 for facing brick (solid masonry units made from clay or shale); ASTM C 652 for hollow brick (hollow masonry units made from clay or shale); and ASTM C 1405 for glazed brick (single-fired solid brick units).

Exception: Structural clay tile for nonstructural use in fireproofing of structural members and in wall furring shall not be required to meet the compressive strength specifications. The fire-resistance rating shall be determined in accordance with ASTM E 119 and shall comply with the requirements of Table 602.

2103.3 AAC masonry. AAC masonry units shall conform to ASTM C 1386 for the strength class specified.

2103.4 Stone masonry units. Stone masonry units shall conform to the following standards: ASTM C 503 for marble building stone (exterior); ASTM C 568 for limestone building stone; ASTM C 615 for granite building stone; ASTM C 616 for sandstone building stone; or ASTM C 629 for slate building stone.

2103.5 Ceramic tile. Ceramic tile shall be as defined in, and shall conform to the requirements of, ANSI A137.1.

2103.6 Glass unit masonry. Hollow glass units shall be partially evacuated and have a minimum average glass face thickness of $^{3}/_{16}$ inch (4.8 mm). Solid glass-block units shall be provided when required. The surfaces of units intended to be in contact with mortar shall be treated with a polyvinyl butyral coating or latex-based paint. Reclaimed units shall not be used.

2103.7 Second-hand units. Second-hand masonry units shall not be reused unless they conform to the requirements of new units. The units shall be of whole, sound materials and free from cracks and other defects that will interfere with proper laying or use. Old mortar shall be cleaned from the unit before reuse.

2103.8 Mortar. Mortar for use in masonry construction shall conform to ASTM C 270 and shall conform to the proportion specifications of Table 2103.8(1) or the property specifications of Table 2103.8(2). Type S or N mortar shall be used for glass unit masonry. The amount of water used in mortar for glass unit masonry shall be adjusted to account for the lack of absorption. Retempering of mortar for glass unit masonry shall not be permitted after initial set. Unused mortar shall be discarded within $2^{1}/_{2}$ hours after initial mixing, except that unused mortar for glass unit masonry shall be discarded within $1^{1}/_{2}$ hours after initial mixing.

2103.9 Surface-bonding mortar. Surface-bonding mortar shall comply with ASTM C 887. Surface bonding of concrete masonry units shall comply with ASTM C 946.

2103.10 Mortars for ceramic wall and floor tile. Portland cement mortars for installing ceramic wall and floor tile shall comply with ANSI A108.1A and ANSI A108.1B and be of the compositions indicated in Table 2103.10.

TABLE 2103.10
CERAMIC TILE MORTAR COMPOSITIONS

LOCATION	MORTAR	COMPOSITION
Walls	Scratchcoat	1 cement; $^{1}/_{5}$ hydrated lime; 4 dry or 5 damp sand
	Setting bed and leveling coat	1 cement; $^{1}/_{2}$ hydrated lime; 5 damp sand to 1 cement 1 hydrated lime, 7 damp sand
Floors	Setting bed	1 cement; $^{1}/_{10}$ hydrated lime; 5 dry or 6 damp sand; or 1 cement; 5 dry or 6 damp sand
Ceilings	Scratchcoat and sand bed	1 cement; $^{1}/_{2}$ hydrated lime; $2^{1}/_{2}$ dry sand or 3 damp sand

2103.10.1 Dry-set portland cement mortars. Premixed prepared portland cement mortars, which require only the addition of water and are used in the installation of ceramic tile, shall comply with ANSI A118.1. The shear bond strength for tile set in such mortar shall be as required in accordance with ANSI A118.1. Tile set in dry-set portland cement mortar shall be installed in accordance with ANSI A108.5.

2103.10.2 Latex-modified portland cement mortar. Latex-modified portland cement thin-set mortars in which latex is added to dry-set mortar as a replacement for all or part of the gauging water that are used for the installation of ceramic tile shall comply with ANSI A118.4. Tile set in latex-modified portland cement shall be installed in accordance with ANSI A108.5.

2103.10.3 Epoxy mortar. Ceramic tile set and grouted with chemical-resistant epoxy shall comply with ANSI A118.3. Tile set and grouted with epoxy shall be installed in accordance with ANSI A108.6.

2103.10.4 Furan mortar and grout. Chemical-resistant furan mortar and grout that are used to install ceramic tile shall comply with ANSI A118.5. Tile set and grouted with furan shall be installed in accordance with ANSI A108.8.

2103.10.5 Modified epoxy-emulsion mortar and grout. Modified epoxy-emulsion mortar and grout that are used to install ceramic tile shall comply with ANSI A118.8. Tile set and grouted with modified epoxy-emulsion mortar and grout shall be installed in accordance with ANSI A108.9.

2103.10.6 Organic adhesives. Water-resistant organic adhesives used for the installation of ceramic tile shall comply with ANSI A136.1. The shear bond strength after water immersion shall not be less than 40 psi (275 kPa) for Type I adhesive and not less than 20 psi (138 kPa) for Type II adhesive when tested in accordance with ANSI A136.1. Tile set in organic adhesives shall be installed in accordance with ANSI A108.4.

2103.10.7 Portland cement grouts. Portland cement grouts used for the installation of ceramic tile shall comply with ANSI A118.6. Portland cement grouts for tile work shall be installed in accordance with ANSI A108.10.

2103.11 Mortar for AAC masonry. Thin-bed mortar for AAC masonry shall comply with Section 2103.11.1. Mortar for lev-

TABLE 2103.8(1)
MORTAR PROPORTIONS

MORTAR	TYPE	PROPORTIONS BY VOLUME (cementitious materials)								AGGREGATE MEASURED IN A DAMP, LOOSE CONDITION
		Portland cement[a] or blended cement[b]	Masonry cement[c] M	Masonry cement[c] S	Masonry cement[c] N	Mortar cement[d] M	Mortar cement[d] S	Mortar cement[d] N	HYDRATED LIME[e] OR LIME PUTTY	
Cement-lime	M	1	—	—	—	—	—	—	$^{1}/_{4}$	Not less than $2^{1}/_{4}$ and not more than 3 times the sum of the separate volumes of cementitious materials
	S	1	—	—	—	—	—	—	over $^{1}/_{4}$ to $^{1}/_{2}$	
	N	1	—	—	—	—	—	—	over $^{1}/_{2}$ to $1^{1}/_{4}$	
	O	1	—	—	—	—	—	—	over $1^{1}/_{4}$ to $2^{1}/_{2}$	
Mortar cement	M	1	—	—	—	—	—	1	—	
	M	—	—	—	—	1	—	—	—	
	S	$^{1}/_{2}$	—	—	—	—	—	1	—	
	S	—	—	—	—	—	1	—	—	
	N	—	—	—	—	—	—	1	—	
	O	—	—	—	—	—	—	1	—	
Masonry cement	M	1	—	—	1	—	—	—	—	
	M	—	1	—	—	—	—	—	—	
	S	$^{1}/_{2}$	—	—	1	—	—	—	—	
	S	—	—	1	—	—	—	—	—	
	N	—	—	—	1	—	—	—	—	
	O	—	—	—	1	—	—	—	—	

a. Portland cement conforming to the requirements of ASTM C 150.
b. Blended cement conforming to the requirements of ASTM C 595.
c. Masonry cement conforming to the requirements of ASTM C 91.
d. Mortar cement conforming to the requirements of ASTM C 1329.
e. Hydrated lime conforming to the requirements of ASTM C 207.

TABLE 2103.8(2)
MORTAR PROPERTIES[a]

MORTAR	TYPE	AVERAGE COMPRESSIVE[b] STRENGTH AT 28 DAYS minimum (psi)	WATER RETENTION minimum (%)	AIR CONTENT maximum (%)
Cement-lime	M	2,500	75	12
	S	1,800	75	12
	N	750	75	14[c]
	O	350	75	14[c]
Mortar cement	M	2,500	75	12
	S	1,800	75	12
	N	750	75	14[c]
	O	350	75	14[c]
Masonry cement	M	2,500	75	18
	S	1,800	75	18
	N	750	75	20[d]
	O	350	75	20[d]

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa.
a. This aggregate ratio (measured in damp, loose condition) shall not be less than $2^{1}/_{4}$ and not more than 3 times the sum of the separate volumes of cementitious materials.
b. Average of three 2-inch cubes of laboratory-prepared mortar, in accordance with ASTM C 270.
c. When structural reinforcement is incorporated in cement-lime or mortar cement mortars, the maximum air content shall not exceed 12 percent.
d. When structural reinforcement is incorporated in masonry cement mortar, the maximum air content shall not exceed 18 percent.

eling courses of AAC masonry shall comply with Section 2103.11.2.

2103.11.1 Thin-bed mortar for AAC masonry. Thin-bed mortar for AAC masonry shall be specifically manufactured for use with AAC masonry. Testing to verify mortar properties shall be conducted by the thin-bed mortar manufacturer and confirmed by an independent testing agency:

1. The compressive strength of thin-bed mortar, as determined by ASTM C 109, shall meet or exceed the strength of the AAC masonry units.
2. The shear strength of thin-bed mortar shall meet or exceed the shear strength of the AAC masonry units for wall assemblages tested in accordance with ASTM E 519.
3. The flexural tensile strength of thin-bed mortar shall not be less than the modulus of rupture of the masonry units. Flexural strength shall be determined by testing in accordance with ASTM E 72 (transverse load test), ASTM E 518 Method A (flexural bond strength test) or ASTM C 1072 (flexural bond strength test).
   - 3.1. For conducting flexural strength tests in accordance with ASTM E 518, at least five test specimens shall be constructed as stack-bonded prisms at least 32 inches (810 mm) high. The type of mortar specified by the AAC unit manufacturer shall be used.
   - 3.2. For flexural strength tests in accordance with ASTM C 1072, test specimens shall be constructed as stack-bonded prisms comprised with at least three bed joints. A total of at least five joints shall be tested using the type of mortar specified by the AAC unit manufacturer.
4. The splitting tensile strength of AAC masonry assemblages composed of two AAC masonry units bonded with one thin-bed mortar joint shall be determined in accordance with ASTM C 1006 and shall equal or exceed $2.4\sqrt{f'_{AAC}}$.

2103.11.2 Mortar for leveling courses of AAC masonry. Mortar used for the leveling courses of AAC masonry shall conform to Section 2103.8 and shall be Type M or S.

2103.12 Grout. Grout shall conform to Table 2103.12 or to ASTM C 476. When grout conforms to ASTM C 476, the grout shall be specified by proportion requirements or property requirements.

TABLE 2103.12
GROUT PROPORTIONS BY VOLUME FOR MASONRY CONSTRUCTION

TYPE	PARTS BY VOLUME OF PORTLAND CEMENT OR BLENDED CEMENT	PARTS BY VOLUME OF HYDRATED LIME OR LIME PUTTY	AGGREGATE, MEASURED IN A DAMP, LOOSE CONDITION	
			Fine	Coarse
Fine grout	1	$0\text{-}^{1}/_{10}$	$2^{1}/_{4}$-3 times the sum of the volumes of the cementitious materials	—
Coarse grout	1	$0\text{-}^{1}/_{10}$	$2^{1}/_{4}$-3 times the sum of the volumes of the cementitious materials	1-2 times the sum of the volumes of the cementitious materials

2103.13 Metal reinforcement and accessories. Metal reinforcement and accessories shall conform to Sections 2103.13.1 through 2103.13.8.

2103.13.1 Deformed reinforcing bars. Deformed reinforcing bars shall conform to one of the following standards: ASTM A 615 for deformed and plain billet-steel bars for concrete reinforcement; ASTM A 706 for low-alloy steel deformed bars for concrete reinforcement; ASTM A 767 for zinc-coated reinforcing steel bars; ASTM A 775 for epoxy-coated reinforcing steel bars; and ASTM A 996 for rail and axle steel-deformed bars for concrete reinforcement.

2103.13.2 Joint reinforcement. Joint reinforcement shall comply with ASTM A 951. The maximum spacing of crosswires in ladder-type joint reinforcement and point of connection of cross wires to longitudinal wires of truss-type reinforcement shall be 16 inches (400 mm).

2103.13.3 Deformed reinforcing wire. Deformed reinforcing wire shall conform to ASTM A 496.

2103.13.4 Wire fabric. Wire fabric shall conform to ASTM A 185 for plain steel-welded wire fabric for concrete reinforcement or ASTM A 497 for welded deformed steel wire fabric for concrete reinforcement.

2103.13.5 Anchors, ties and accessories. Anchors, ties and accessories shall conform to the following standards: ASTM A 36 for structural steel; ASTM A 82 for plain steel wire for concrete reinforcement; ASTM A 185 for plain steel-welded wire fabric for concrete reinforcement; ASTM A 240 for chromium and chromium-nickel stainless steel plate, sheet and strip; ASTM A 307 Grade A for anchor bolts; ASTM A 480 for flat rolled stainless and heat-resisting steel plate, sheet and strip; and ASTM A 1008 for cold-rolled carbon steel sheet.

2103.13.6 Prestressing tendons. Prestressing tendons shall conform to one of the following standards:

1. Wire . . . . ASTM A 421
2. Low-relaxation wire . . . . ASTM A 421
3. Strand . . . . ASTM A 416
4. Low-relaxation strand . . . . ASTM A 416

5. Bar . . . . ASTM A 722

Exceptions:

1. Wire, strands and bars not specifically listed in ASTM A 421, ASTM A 416 or ASTM A 722 are permitted, provided they conform to the minimum requirements in ASTM A 421, ASTM A 416 or ASTM A 722 and are approved by the architect/engineer.
2. Bars and wires of less than 150 kips per square inch (ksi) (1034 MPa) tensile strength and conforming to ASTM A 82, ASTM A 510, ASTM A 615, ASTM A 996 or ASTM A 706 are permitted to be used as prestressed tendons, provided that:
   - 2.1. The stress relaxation properties have been assessed by tests according to ASTM E 328 for the maximum permissible stress in the tendon.
   - 2.2. Other nonstress-related requirements of ACI 530/ASCE 5/TMS 402, Chapter 4, addressing prestressing tendons are met.

2103.13.7 Corrosion protection. Corrosion protection for prestressing tendons shall comply with the requirements of ACI 530.1/ASCE 6/TMS 602, Article 2.4G. Corrosion protection for prestressing anchorages, couplers and end blocks shall comply with the requirements of ACI 530.1/ASCE 6/TMS 602, Article 2.4H. Corrosion protection for carbon steel accessories used in exterior wall construction or interior walls exposed to a mean relative humidity exceeding 75 percent shall comply with either Section 2103.13.7.2 or 2103.13.7.3. Corrosion protection for carbon steel accessories used in interior walls exposed to a mean relative humidity equal to or less than 75 percent shall comply with either Section 2103.13.7.1, 2103.13.7.2 or 2103.13.7.3.

2103.13.7.1 Mill galvanized. Mill galvanized coatings shall be applied as follows:

1. For joint reinforcement, wall ties, anchors and inserts, a minimum coating of 0.1 ounce per square foot (31g/m^2) complying with the requirements of ASTM A 641 shall be applied.
2. For sheet metal ties and sheet metal anchors, a minimum coating complying with Coating Designation G-60 according to the requirements of ASTM A 653 shall be applied.
3. For anchor bolts, steel plates or bars not exposed to the earth, weather or a mean relative humidity exceeding 75 percent, a coating is not required.

2103.13.7.2 Hot-dipped galvanized. Hot-dipped galvanized coatings shall be applied after fabrication as follows:

1. For joint reinforcement, wall ties, anchors and inserts, a minimum coating of 1.5 ounces per square foot (458 g/m^2) complying with the requirements of ASTM A 153, Class B shall be applied.
2. For sheet metal ties and anchors, the requirements of ASTM A 153, Class B shall be met.
3. For steel plates and bars, the requirements of either ASTM A 123 or ASTM A 153, Class B shall be met.

2103.13.7.3 Epoxy coatings. Carbon steel accessories shall be epoxy coated as follows:

1. For joint reinforcement, the requirements of ASTM A 884, Class A, Type 1 having a minimum thickness of 7 mils (175 μm) shall be met.
2. For wire ties and anchors, the requirements of ASTM A 899, Class C having a minimum thickness of 20 mils (508 μm) shall be met.
3. For sheet metal ties and anchors, a minimum thickness of 20 mils (508 μm) per surface shall be provided or a minimum thickness in accordance with the manufacturer's specification shall be provided.

2103.13.8 Tests. Where unidentified reinforcement is approved for use, not less than three tension and three bending tests shall be made on representative specimens of the reinforcement from each shipment and grade of reinforcing steel proposed for use in the work.

SECTION 2104
CONSTRUCTION

2104.1 Masonry construction. Masonry construction shall comply with the requirements of Sections 2104.1.1 through 2104.5 and with ACI 530.1/ASCE 6/TMS 602.

2104.1.1 Tolerances. Masonry, except masonry veneer, shall be constructed within the tolerances specified in ACI 530.1/ASCE 6/TMS 602.

2104.1.2 Placing mortar and units. Placement of mortar and clay and concrete units shall comply with Sections 2104.1.2.1, 2104.1.2.2, 2104.1.2.3 and 2104.1.2.5. Placement of mortar and glass unit masonry shall comply with Sections 2104.1.2.4 and 2104.1.2.5. Placement of thin-bed mortar and AAC masonry shall comply with Section 2104.1.2.6.

2104.1.2.1 Bed and head joints. Unless otherwise required or indicated on the construction documents, head and bed joints shall be $^3/_8$ inch (9.5 mm) thick, except that the thickness of the bed joint of the starting course placed over foundations shall not be less than $^1/_4$ inch (6.4 mm) and not more than $^3/_4$ inch (19.1 mm).

2104.1.2.1.1 Open-end units. Open-end units with beveled ends shall be fully grouted. Head joints of open-end units with beveled ends need not be mortared. The beveled ends shall form a grout key that permits grouts within $^5/_8$ inch (15.9 mm) of the face of the unit. The units shall be tightly butted to prevent leakage of the grout.

2104.1.2.2 Hollow units. Hollow units shall be placed such that face shells of bed joints are fully mortared. Webs shall be fully mortared in all courses of piers, columns, pilasters, in the starting course on foundations where adjacent cells or cavities are to be grouted, and where otherwise required. Head joints shall be mortared a minimum distance from each face equal to the face shell thickness of the unit.

2104.1.2.3 Solid units. Unless otherwise required or indicated on the construction documents, solid units shall be placed in fully mortared bed and head joints. The ends of the units shall be completely buttered. Head joints shall not be filled by slushing with mortar. Head joints shall be constructed by shoving mortar tight against the adjoining unit. Bed joints shall not be furrowed deep enough to produce voids.

2104.1.2.4 Glass unit masonry. Glass units shall be placed so head and bed joints are filled solidly. Mortar shall not be furrowed.

Unless otherwise required, head and bed joints of glass unit masonry shall be $^1/_4$ inch (6.4 mm) thick, except that vertical joint thickness of radial panels shall not be less than $^1/_8$ inch (3.2 mm). The bed joint thickness tolerance shall be minus $^1/_{16}$ inch (1.6 mm) and plus $^1/_8$ inch (3.2 mm). The head joint thickness tolerance shall be plus or minus $^1/_8$ inch (3.2 mm).

2104.1.2.5 Placement in mortar. Units shall be placed while the mortar is soft and plastic. Any unit disturbed to the extent that the initial bond is broken after initial positioning shall be removed and relaid in fresh mortar.

2104.1.2.6 Thin-bed mortar and AAC masonry units. AAC masonry construction shall begin with a leveling course of masonry meeting the requirements of Section 2104.1.2. Subsequent courses of AAC masonry units shall be laid with thin-bed mortar using a special notched trowel manufactured for use with thin-bed mortar to spread the mortar so that it completely fills the bed joints. Unless otherwise specified, the head joints shall be similarly filled. Joints in AAC masonry shall be approximately $^1/_{16}$ inch (1.5 mm) and shall be formed by striking on the ends and tops of AAC masonry units with a rubber mallet. Minor adjustments in unit position shall be made while the mortar is still soft and plastic by tapping it into the proper position. Minor sanding of the exposed faces of AAC masonry shall be permitted to provide a smooth and plumb surface.

2104.1.2.7 Grouted masonry. Between grout pours, a horizontal construction joint shall be formed by stopping all wythes at the same elevation and with the grout stopping a minimum of $1^1/_2$ inches (38 mm) below a mortar joint, except at the top of the wall. Where bond beams occur, the grout pour shall be stopped a minimum of $^1/_2$ inch (12.7 mm) below the top of the masonry.

2104.1.3 Installation of wall ties. The ends of wall ties shall be embedded in mortar joints. Wall tie ends shall engage outer face shells of hollow units by at least $^1/_2$ inch (12.7 mm). Wire wall ties shall be embedded at least $1^1/_2$ inches (38 mm) into the mortar bed of solid masonry units or solid-grouted hollow units. Wall ties shall not be bent after being embedded in grout or mortar.

2104.1.4 Chases and recesses. Chases and recesses shall be constructed as masonry units are laid. Masonry directly above chases or recesses wider than 12 inches (305 mm) shall be supported on lintels.

2104.1.5 Lintels. The design for lintels shall be in accordance with the masonry design provisions of either Section 2107 or 2108. Minimum length of end support shall be 4 inches (102 mm).

2104.1.6 Support on wood. Masonry shall not be supported on wood girders or other forms of wood construction except as permitted in Section 2304.12.

2104.1.7 Masonry protection. The top of unfinished masonry work shall be covered to protect the masonry from the weather.

2104.1.8 Weep holes. Weep holes provided in the outside wythe of masonry walls shall be at a maximum spacing of 33 inches (838 mm) on center (o.c.). Weep holes shall not be less than $^3/_{16}$ inch (4.8 mm) in diameter.

2104.1.9 Bracing of masonry. Bracing that will ensure stability of masonry during construction shall be provided and installed. Bracing shall be in accordance with the *Standard Practice for Bracing Masonry Walls Under Construction*.

Exceptions:

1. Bracing shall not be required for the unsupported wall heights specified in the *Standard Practice for Bracing Masonry Walls Under Construction*, Appendix A, when an evacuation system complying with the *Standard Practice for Bracing Masonry Walls Under Construction with Commentary* is provided.
2. Walls 8 feet (2438 mm) and less in height above grade shall not require bracing.

2104.2 Corbeled masonry. Except for corbels designed per Section 2107 or 2108, the following shall apply:

1. Corbels shall be constructed of solid masonry units.
2. The maximum corbeled projection beyond the face of the wall shall not exceed:
   - 2.1. One-half of the wall thickness for multiwythe walls bonded by mortar or grout and wall ties or masonry headers or
   - 2.2. One-half the wythe thickness for single wythe walls, masonry bonded hollow walls, multiwythe walls with open collar joints and veneer walls.
3. The maximum projection of one unit shall not exceed:
   - 3.1. One-half the nominal unit height of the unit or
   - 3.2. One-third the nominal thickness of the unit or wythe.
4. The back surface of the corbelled section shall remain within 1 inch (25 mm) of plane.

2104.2.1 Molded cornices. Unless structural support and anchorage are provided to resist the overturning moment, the center of gravity of projecting masonry or molded cornices shall lie within the middle one-third of the supporting wall. Terra cotta and metal cornices shall be provided with a structural frame of approved noncombustible material anchored in an approved manner.

2104.3 Cold weather construction. The cold weather construction provisions of ACI 530.1/ASCE 6/TMS 602, Article 1.8 C, or the following procedures shall be implemented when either the ambient temperature falls below 40°F (4°C) or the temperature of masonry units is below 40°F (4°C).

2104.3.1 Preparation.

1. Temperatures of masonry units shall not be less than 20°F (-7°C) when laid in the masonry. Masonry units containing frozen moisture, visible ice or snow on their surface shall not be laid.
2. Visible ice and snow shall be removed from the top surface of existing foundations and masonry to receive new construction. These surfaces shall be heated to above freezing, using methods that do not result in damage.

2104.3.2 Construction. The following requirements shall apply to work in progress and shall be based on ambient temperature.

2104.3.2.1 Construction requirements for temperatures between 40°F (4°C) and 32°F (0°C). The following construction requirements shall be met when the ambient temperature is between 40°F (4°C) and 32°F (0°C):

1. Glass unit masonry shall not be laid.
2. Water and aggregates used in mortar and grout shall not be heated above 140°F (60°C).
3. Mortar sand or mixing water shall be heated to produce mortar temperatures between 40°F (4°C) and 120°F (49°C) at the time of mixing. When water and aggregates for grout are below 32°F(0°C), they shall be heated.

2104.3.2.2 Construction requirements for temperatures between 32°F (0°C) and 25°F (-4°C). The requirements of Section 2104.3.2.1 and the following construction requirements shall be met when the ambient temperature is between 32°F (0°C) and 25°F (-4°C):

1. The mortar temperature shall be maintained above freezing until used in masonry.
2. Aggregates and mixing water for grout shall be heated to produce grout temperature between 70°F (21°C) and 120°F (49°C) at the time of mixing. Grout temperature shall be maintained above 70°F (21°C) at the time of grout placement.
3. Heat AAC masonry units to a minimum temperature of 40°F (4°C) before installing thin-bed mortar.

2104.3.2.3 Construction requirements for temperatures between 25°F (-4°C) and 20°F (-7°C). The requirements of Sections 2104.3.2.1 and 2104.3.2.2 and the following construction requirements shall be met when the ambient temperature is between 25°F (-4°C) and 20°F (-7°C):

1. Masonry surfaces under construction shall be heated to 40°F (4°C).
2. Wind breaks or enclosures shall be provided when the wind velocity exceeds 15 miles per hour (mph) (24 km/h).
3. Prior to grouting, masonry shall be heated to a minimum of 40°F (4°C).

2104.3.2.4 Construction requirements for temperatures below 20°F (-7°C). The requirements of Sections 2104.3.2.1, 2104.3.2.2 and 2104.3.2.3 and the following construction requirement shall be met when the ambient temperature is below 20°F (-7°C): Enclosures and auxiliary heat shall be provided to maintain air temperature within the enclosure to above 32°F (0°C).

2104.3.3 Protection. The requirements of this section and Sections 2104.3.3.1 through 2104.3.3.5 apply after the masonry is placed and shall be based on anticipated minimum daily temperature for grouted masonry and anticipated mean daily temperature for ungrouted masonry.

2104.3.3.1 Glass unit masonry. The temperature of glass unit masonry shall be maintained above 40°F (4°C) for 48 hours after construction.

2104.3.3.2 AAC masonry. The temperature of AAC masonry shall be maintained above 32°F (0°C) for the first 4 hours after thin-bed mortar application.

2104.3.3.3 Protection requirements for temperatures between 40°F (4°C) and 25°F (-4°C). When the temperature is between 40°F (4°C) and 25°F (-4°C), newly constructed masonry shall be covered with a weather-resistive membrane for 24 hours after being completed.

2104.3.3.4 Protection requirements for temperatures between 25°F (-4°C) and 20°F (-7°C). When the temperature is between 25°F (-4°C) and 20°F (-7°C), newly constructed masonry shall be completely covered with weather-resistive insulating blankets, or equal protection, for 24 hours after being completed. The time period shall be extended to 48 hours for grouted masonry, unless the only cement in the grout is Type III portland cement.

2104.3.3.5 Protection requirements for temperatures below 20°F (-7°C). When the temperature is below 20°F (-7°C), newly constructed masonry shall be maintained at a temperature above 32°F (0°C) for at least 24 hours after being completed by using heated enclosures, electric heating blankets, infrared lamps or other acceptable methods. The time period shall be extended to 48 hours for grouted masonry, unless the only cement in the grout is Type III portland cement.

2104.4 Hot weather construction. The hot weather construction provisions of ACI 530.1/ASCE 6/TMS 602, Article 1.8 D, or the following procedures shall be implemented when the temperature or the temperature and wind-velocity limits of this section are exceeded.

2104.4.1 Preparation. The following requirements shall be met prior to conducting masonry work.

2104.4.1.1 Temperature. When the ambient temperature exceeds 100°F (38°C), or exceeds 90°F (32°C) with a wind velocity greater than 8 mph (3.5 m/s):

1. Necessary conditions and equipment shall be provided to produce mortar having a temperature below 120°F (49°C).
2. Sand piles shall be maintained in a damp, loose condition.

2104.4.1.2 Special conditions. When the ambient temperature exceeds 115°F (46°C), or 105°F (40°C) with a wind velocity greater than 8 mph (3.5 m/s), the requirements of Section 2104.4.1.1 shall be implemented, and materials and mixing equipment shall be shaded from direct sunlight.

2104.4.2 Construction. The following requirements shall be met while masonry work is in progress.

2104.4.2.1 Temperature. When the ambient temperature exceeds 100°F (38°C), or exceeds 90°F (32°C) with a wind velocity greater than 8 mph (3.5 m/s):

1. The temperature of mortar and grout shall be maintained below 120°F (49°C).
2. Mixers, mortar transport containers and mortar boards shall be flushed with cool water before they come into contact with mortar ingredients or mortar.
3. Mortar consistency shall be maintained by retempering with cool water.
4. Mortar shall be used within 2 hours of initial mixing.
5. Thin-bed mortar shall be spread no more than 4 feet (1219 mm) ahead of AAC masonry units.
6. AAC masonry units shall be placed within one minute after spreading thin-bed mortar.

2104.4.2.2 Special conditions. When the ambient temperature exceeds 115°F (46°C), or exceeds 105°F (40°C) with a wind velocity greater than 8 mph (3.5 m/s), the requirements of Section 2104.4.2.1 shall be implemented and cool mixing water shall be used for mortar and grout. The use of ice shall be permitted in the mixing water prior to use. Ice shall not be permitted in the mixing water when added to the other mortar or grout materials.

2104.4.3 Protection. When the mean daily temperature exceeds 100°F (38°C) or exceeds 90°F (32°C) with a wind velocity greater than 8 mph (3.5 m/s), newly constructed masonry shall be fog sprayed until damp at least three times a day until the masonry is three days old.

2104.5 Wetting of brick. Brick (clay or shale) at the time of laying shall require wetting if the unit's initial rate of water absorption exceeds 30 grams per 30 square inches (19 355 mm^2) per minute or 0.035 ounce per square inch (1 g/645 mm^2) per minute, as determined by ASTM C 67.

SECTION 2105 QUALITY ASSURANCE

2105.1 General. A quality assurance program shall be used to ensure that the constructed masonry is in compliance with the construction documents.

2105.2 Acceptance relative to strength requirements.

2105.2.1 Compliance with f'_m and f'_{AAC}. Compressive strength of masonry shall be considered satisfactory if the compressive strength of each masonry wythe and grouted collar joint equals or exceeds the value of f'_m for clay and concrete masonry and f'_{AAC} for AAC masonry. For partially grouted clay and concrete masonry, the compressive strength of both the grouted and ungrouted masonry shall equal or exceed the applicable f'_m . At the time of prestress, the compressive strength of the masonry shall equal or exceed f'_{mi}, which shall be less than or equal to f'_m.

2105.2.2 Determination of compressive strength. The compressive strength for each wythe shall be determined by the unit strength method or by the prism test method as specified herein.

2105.2.2.1 Unit strength method.

2105.2.2.1.1 Clay masonry. The compressive strength of masonry shall be determined based on the strength of the units and the type of mortar specified using Table 2105.2.2.1.1, provided:

1. Units conform to ASTM C 62, ASTM C 216 or ASTM C 652 and are sampled and tested in accordance with ASTM C 67.
2. Thickness of bed joints does not exceed $^5/_8$ inch (15.9 mm).
3. For grouted masonry, the grout meets one of the following requirements:
   3.1. Grout conforms to ASTM C 476.
   3.2. Minimum grout compressive strength equals or exceeds f'_m but not less than 2,000 psi (13.79 MPa). The compressive strength of grout shall be determined in accordance with ASTM C 1019.

TABLE 2105.2.2.1.1
COMPRESSIVE STRENGTH OF CLAY MASONRY

NET AREA COMPRESSIVE STRENGTH OF CLAY MASONRY UNITS (psi)		NET AREA COMPRESSIVE STRENGTH OF MASONRY (psi)
Type M or S mortar	Type N mortar	
1,700	2,100	1,000
3,350	4,150	1,500
4,950	6,200	2,000
6,600	8,250	2,500
8,250	10,300	3,000
9,900	—	3,500
13,200	—	4,000

For SI: 1 pound per square inch = 0.00689 MPa.

2105.2.2.1.2 Concrete masonry. The compressive strength of masonry shall be determined based on the strength of the unit and type of mortar specified using Table 2105.2.2.1.2, provided:

1. Units conform to ASTM C 55 or ASTM C 90 and are sampled and tested in accordance with ASTM C 140.
2. Thickness of bed joints does not exceed $^5/_8$ inch (15.9 mm).
3. For grouted masonry, the grout meets one of the following requirements:
   3.1. Grout conforms to ASTM C 476.
   3.2. Minimum grout compressive strength equals or exceeds f'_m but not less than 2,000 psi (13.79 MPa). The compressive strength of grout shall be determined in accordance with ASTM C 1019.

TABLE 2105.2.2.1.2
COMPRESSIVE STRENGTH OF CONCRETE MASONRY

NET AREA COMPRESSIVE STRENGTH OF CONCRETE MASONRY UNITS (psi)		NET AREA COMPRESSIVE STRENGTH OF MASONRY (psi)[a]
Type M or S mortar	Type N mortar	
1,250	1,300	1,000
1,900	2,150	1,500
2,800	3,050	2,000
3,750	4,050	2,500
4,800	5,250	3,000

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 0.00689 MPa.
a. For units less than 4 inches in height, 85 percent of the values listed.

2105.2.2.1.3 AAC masonry. The compressive strength of AAC masonry shall be based on the strength of the AAC masonry unit only and the following shall be met:

1. Units conform to ASTM C 1386.
2. Thickness of bed joints does not exceed $^1/_8$ inch (3.2 mm).
3. For grouted masonry, the grout meets one of the following requirements:
   3.1. Grout conforms to ASTM C 476.
   3.2. Minimum grout compressive strength equals or exceeds f'_{AAC} but not less than 2,000 psi (13.79 MPa). The compressive strength of grout shall be determined in accordance with ASTM C 1019.

2105.2.2.2 Prism test method.

2105.2.2.2.1 General. The compressive strength of clay and concrete masonry shall be determined by the prism test method:

1. Where specified in the construction documents.
2. Where masonry does not meet the requirements for application of the unit strength method in Section 2105.2.2.1.

2105.2.2.2.2 Number of prisms per test. A prism test shall consist of three prisms constructed and tested in accordance with ASTM C 1314.

2105.3 Testing prisms from constructed masonry. When approved by the building official, acceptance of masonry that does not meet the requirements of Section 2105.2.2.1 or 2105.2.2.2 shall be permitted to be based on tests of prisms cut from the masonry construction in accordance with Sections 2105.3.1, 2105.3.2 and 2105.3.3.

2105.3.1 Prism sampling and removal. A set of three masonry prisms that are at least 28 days old shall be saw cut from the masonry for each 5,000 square feet (465 m^2) of the wall area that is in question but not less than one set of three masonry prisms for the project. The length, width and height dimensions of the prisms shall comply with the requirements of ASTM C 1314. Transporting, preparation and testing of prisms shall be in accordance with ASTM C 1314.

2105.3.2 Compressive strength calculations. The compressive strength of prisms shall be the value calculated in accordance ASTM C 1314, except that the net cross-sectional area of the prism shall be based on the net mortar bedded area.

2105.3.3 Compliance. Compliance with the requirement for the specified compressive strength of masonry, f'_m, shall be considered satisfied provided the modified compressive strength equals or exceeds the specified f'_m. Additional testing of specimens cut from locations in question shall be permitted.

SECTION 2106
SEISMIC DESIGN
RESERVED

SECTION 2107
ALLOWABLE STRESS DESIGN

2107.1 General. The design of masonry structures using allowable stress design shall comply with the requirements of Chapters 1 and 2 of ACI 530/ASCE 5/TMS 402 except as modified by Section 2107.2. Lap splices shall be in accordance with ACI 530/ASCE 5/TMS 402 or in accordance with Section 2107.3 or 2107.5 as specified by the architect or engineer. Development of bars in tension and compression shall be in accordance with ACI 530/ASCE 5/TMS 402 or in accordance with 2107.4 as specified by the architect or engineer.

Exception: Where inspections are performed by a local building department in accordance with Section 105, the provisions of ACI 530/ASCE 5/TMS 402, Chapter 1, Section 1-15 and ACI 530.1/ASCE 6/TMS 602. Section 1.6 shall not apply unless specified by the architect or engineer.

2107.2 ACI 530/ASCE 5/TMS 402, Section 2.1.6, columns. Add the following text to Section 2.1.6:

2.1.6.6 Light-frame construction. Masonry columns used only to support light-frame roofs of carports, porches, sheds or similar structures with a maximum area of 450 square feet (41.8 m^2) are permitted to be designed and constructed as follows:

1. Concrete masonry materials shall be in accordance with Section 2103.1 of the *Florida Building Code, Building*. Clay or shale masonry units shall be in accordance with Section 2103.2 of the *Florida Building Code, Building*.
2. The nominal cross-sectional dimension of columns shall not be less than 8 inches (203 mm).
3. Columns shall be reinforced with not less than one No. 4 bar centered in each cell of the column.
4. Columns shall be grouted solid.
5. Columns shall not exceed 12 feet (3658 mm) in height.
6. Roofs shall be anchored to the columns. Such anchorage shall be capable of resisting the design loads specified in Chapter 16 of the *Florida Building Code, Building*.
7. Where such columns are required to resist uplift loads, the columns shall be anchored to their footings with two No. 4 bars extending a minimum of 24 inches (610 mm) into the columns and bent horizontally a minimum of 15 inches (381 mm) in opposite directions into the footings. One of these bars is permitted to be the reinforcing bar specified in Item 3 above. The total weight of a column and its footing shall not be less than 1.5 times the design uplift load.

2107.3 ACI 530/ASCE 5/TMS 402, Section 2.1.10.7.1.1, lap splices. Modify Section 2.1.10.7.1.1 as follows:

2.1.10.7.1.1 The minimum length of lap splices for reinforcing bars in tension or compression, l_d, shall be

$l_d = 0.002 d_b f_s$ **(Equation 21-2)**

For SI: $l_d = 0.29 d_b f_s$

but not less than 12 inches (305 mm). In no case shall the length of the lapped splice be less than 40 bar diameters.

where:

d_b = Diameter of reinforcement, inches (mm).

f_s = Computed stress in reinforcement due to design loads, psi (MPa).

In regions of moment where the design tensile stresses in the reinforcement are greater than 80 percent of the allowable steel tension stress, F_s, the lap length of splices shall be increased not less than 50 percent of the minimum required length. Other equivalent means of stress transfer to accomplish the same 50 percent increase shall be permitted.

Where epoxy coated bars are used, lap length shall be increased by 50 percent.

2107.4 ACI 530/ASCE 5/TMS 402, Section 2.1.10.3, Development of bars in tension and compression. Modify Section 2.1.10.3 as follows:

2.1.10.3 The required development length of reinforcing bars shall be determined by Equation (2-9), but shall not be less than 12 inches (305 mm), but need not be greater than 72 d_b.

Equation 2-9 from ACI 530/ASCE 5/TMS 402, unchanged.

K shall not exceed the lesser of the masonry cover, clear spacing between adjacent reinforcement, nor 5 times d_b.

γ = 1.0 for No. 3 (M#10) through No. 5 (M#16) bars;

γ = 1.04 for No. 6 (M#19) through No. 7 (M#22) bars; and

γ = 1.2 for No. 8 (M#25) through No. 11 (M#36) bars

Where epoxy coated bars are used. lap length shall be increased by 50 percent.

2107.5 ACI 530/ASCE 5/TMS 402, Section 2.1.10.7, splices of reinforcement. Modify Section 2.1.10.7 as follows:

2.1.10.7 Splices of reinforcement. Lap splices, welded splices or mechanical splices are permitted in accordance with the provisions of this section. All welding shall conform to AWS D1.4. Reinforcement larger than No. 9 (M #29) shall be spliced using mechanical connections in accordance with Section 2.1.10.7.3.

SECTION 2108
STRENGTH DESIGN OF MASONRY

2108.1 General. The design of masonry structures using strength design shall comply with the requirements of Chapters 1 and 3 of ACI 530/ASCE 5/TMS 402, except as modified by Sections 2108.2 and 2108.3.

Exceptions:

1. AAC masonry shall comply with the requirements of Chapter 1 and Appendix A of ACI 530/ASCE 5/TMS 402.
2. Where inspections are performed by a local building department in accordance with Section 105, the provisions of ACI 530/ASCE 5/TMS 402, Chapter 1, Section 1-15 and ACI 530.1/ASCE 6/TMS 602, Section 1.6 shall not apply unless specified by the architect or engineer.

2108.2 ACI 530/ASCE 5/TMS 402, Section 3.3.3.3. Modify Section 3.3.3.3 as follows:

3.3.3.3 Development - The required development length of reinforcement shall be determined by Equation (3-15), but shall not be less than 12 inches (305 mm) and need not be greater than 72 d_b.

Equation 3-15 from ACI 530/ASCE 5/TMS 402, unchanged

K shall not exceed the lesser of the masonry cover, clear spacing between adjacent reinforcement, nor 5 times d_b.

γ = 1.0 for No. 3 (M#10) through No. 5 (M#16) bars;

γ = 1.04 for No. 6 (M#19) through No. 7 (M#22) bars; and

γ = 1.2 for No. 8 (M#25) through No. 11 (M#36) bars

Where epoxy coated bars are used. lap length shall be increased by 50 percent.

2108.3 ACI 530/ASCE 5/TMS 402, Section 3.3.3.5, maximum areas of flexural tensile reinforcement. Add the following text to Section 3.3.3.5:

3.3.3.5.5 For special prestressed masonry shear walls, strain in all prestressing steel shall be computed to be compatible with a strain in the extreme tension reinforcement equal to five times the strain associated with the reinforcement yield stress, f_y. The calculation of the maximum reinforcement shall consider forces in the prestressing steel that correspond to these calculated strains.

SECTION 2109
EMPIRICAL DESIGN OF MASONRY

2109.1 General. Empirically designed masonry shall conform to this chapter or Chapter 5 of ACI 530/ASCE 5/TMS 402.

2109.1.1 Limitations. The use of empirical design of masonry shall be limited as follows:

1. Empirical design shall not be used for masonry elements that are part of the lateral-force-resisting system where the basic wind speed exceeds 100 mph (45 m/s).
2. Empirical design shall not be used for interior masonry elements that are not part of the lateral force-resisting system in buildings other than enclosed buildings as defined in Chapter 6 of ASCE 7 in:
   - 2.1. Buildings over 180 feet (55 100 mm) in height.
   - 2.2. Buildings over 60 feet (18 400 mm) in height where the basic wind speed exceeds 90 mph (40 m/s).
   - 2.3. Buildings over 35 feet (10 700 mm) in height where the basic wind speed exceeds 100 mph (45 m/s).
   - 2.4. Where the basic wind speed exceeds 100 mph (45 m/s).
3. Empirical design shall not be used for exterior masonry elements that are not part of the lateral force-resisting system and that are more than 35 feet (10 700 mm) above ground:
   - 3.1. Buildings over 180 feet (55 100 mm) in height.
   - 3.2. Buildings over 60 feet (18 400 mm) in height where the basic wind speed exceeds 90 mph (40 m/s).
   - 3.3. Buildings over 35 feet (10 700 mm) in height where the basic wind speed exceeds 100 mph (45 m/s).
4. Empirical design shall not be used for exterior masonry elements that are less than or equal to 35 feet (10 700 mm) above ground where the basic wind speed exceeds 100 mph (45 m/s).
5. Empirical design shall be used only when the resultant of gravity loads is within the center third of the wall thickness and within the central area bounded by lines at one-third of each cross-sectional dimension of foundation piers.
6. Empirical design shall not be used for AAC masonry.

In buildings that exceed one or more of the above limitations, masonry shall be designed in accordance with the engineered design provisions of Section 2107 or 2108 or the foundation wall provisions of Section 1805.5.

2109.2 Lateral stability.

2109.2.1 Shear walls. Where the structure depends upon masonry walls for lateral stability, shear walls shall be provided parallel to the direction of the lateral forces resisted.

2109.2.1.1 Cumulative length of shear walls. In each direction in which shear walls are required for lateral stability, shear walls shall be positioned in two separate planes. The minimum cumulative length of shear walls provided shall be 0.4 times the long dimension of the building. Cumulative length of shear walls shall not include openings or any element with a length that is less than one-half its height.

2109.2.1.2 Maximum diaphragm ratio. Masonry shear walls shall be spaced so that the length-to-width ratio of each diaphragm transferring lateral forces to the shear walls does not exceed the values given in Table 2109.2.1.2.

TABLE 2109.2.1.2
DIAPHRAGM LENGTH-TO-WIDTH RATIOS

FLOOR OR ROOF DIAPHRAGM CONSTRUCTION	MAXIMUM LENGTH-TO-WIDTH RATIO OF DIAPHRAGM PANEL
Cast-in-place concrete	5:1
Precast concrete	4:1
Metal deck with concrete fill	3:1
Metal deck with no fill	2:1
Wood	2:1

2109.2.2 Roofs. The roof construction shall be designed so as not to impart out-of-plane lateral thrust to the walls under roof gravity load.

2109.2.3 Surface-bonded walls. Dry-stacked, surface-bonded concrete masonry walls shall comply with the requirements of this code for masonry wall construction, except where otherwise noted in this section.

2109.2.3.1 Strength. Dry-stacked, surface-bonded concrete masonry walls shall be of adequate strength and proportions to support all superimposed loads without exceeding the allowable stresses listed in Table 2109.2.3.1. Allowable stresses not specified in Table 2109.2.3.1 shall comply with the requirements of ACI 530/ASCE 5/TMS 402.

TABLE 2109.2.3.1
ALLOWABLE STRESS GROSS CROSS-SECTIONAL AREA FOR DRY-STACKED, SURFACE-BONDED CONCRETE MASONRY WALLS

DESCRIPTION	MAXIMUM ALLOWABLE STRESS (psi)
Compression standard block	45
Flexural tension	
Horizontal span	30
Vertical span	18
Shear	10

For SI: 1 pound per square inch = 0.006895 MPa.

2109.2.3.2 Construction. Construction of dry-stacked, surface-bonded masonry walls, including stacking and leveling of units, mixing and application of mortar and curing and protection shall comply with ASTM C 946.

2109.3 Compressive stress requirements.

2109.3.1 Calculations. Compressive stresses in masonry due to vertical dead plus live loads, excluding wind loads, shall be determined in accordance with Section 2109.3.2.1. Dead and live loads shall be in accordance with Chapter 16, with live load reductions as permitted in Section 1607.9.

2109.3.2 Allowable compressive stresses. The compressive stresses in masonry shall not exceed the values given in Table 2109.3.2. Stress shall be calculated based on specified rather than nominal dimensions.

2109.3.2.1 Calculated compressive stresses. Calculated compressive stresses for single wythe walls and for multiwythe composite masonry walls shall be determined by dividing the design load by the gross cross-sectional area of the member. The area of openings, chases or recesses in walls shall not be included in the gross cross-sectional area of the wall.

2109.3.2.2 Multiwythe walls. The allowable stress shall be as given in Table 2109.3.2 for the weakest combination of the units used in each wythe.

2109.4 Lateral support.

2109.4.1 Intervals. Masonry walls shall be laterally supported in either the horizontal or vertical direction at intervals not exceeding those given in Table 2109.4.1.

TABLE 2109.4.1
WALL LATERAL SUPPORT REQUIREMENTS

CONSTRUCTION	MAXIMUM WALL LENGTH TO THICKNESS OR WALL HEIGHT TO THICKNESS
Bearing walls	
Solid units or fully grouted	20
All others	18
Nonbearing walls	
Exterior	18
Interior	36

2109.4.2 Thickness. Except for cavity walls and cantilever walls, the thickness of a wall shall be its nominal thickness measured perpendicular to the face of the wall. For cavity walls, the thickness shall be determined as the sum of the nominal thicknesses of the individual wythes. For cantilever walls, except for parapets, the ratio of height-to-nominal thickness shall not exceed 6 for solid masonry or 4 for hollow masonry. For parapets, see Section 2109.5.4.

2109.4.3 Support elements. Lateral support shall be provided by cross walls, pilasters, buttresses or structural frame members when the limiting distance is taken horizontally, or by floors, roofs acting as diaphragms or structural frame members when the limiting distance is taken vertically.

2109.5 Thickness of masonry. Minimum thickness requirements shall be based on nominal dimensions of masonry.

2109.5.1 Thickness of walls. The thickness of masonry walls shall conform to the requirements of Section 2109.5.

2109.5.2 Minimum thickness.

2109.5.2.1 Bearing walls. The minimum thickness of masonry bearing walls more than one story high shall be 8 inches (203 mm). Bearing walls of one-story buildings shall not be less than 6 inches (152 mm) thick.

2109.5.2.2 Rubble stone walls. The minimum thickness of rough, random or coursed rubble stone walls shall be 16 inches (406 mm).

2109.5.2.3 Shear walls. The minimum thickness of masonry shear walls shall be 8 inches (203 mm).

2109.5.2.4 Foundation walls. The minimum thickness of foundation walls shall be 8 inches (203 mm) and as required by Section 2109.5.3.1.

2109.5.2.5 Foundation piers. The minimum thickness of foundation piers shall be 8 inches (203 mm).

2109.5.2.6 Parapet walls. The minimum thickness of parapet walls shall be 8 inches (203 mm) and as required by Section 2109.5.4.1.

2109.5.2.7 Change in thickness. Where walls of masonry of hollow units or masonry bonded hollow walls are decreased in thickness, a course or courses of solid masonry shall be interposed between the wall below and the thinner wall above, or special units or construction shall be used to transmit the loads from face shells or wythes above to those below.

2109.5.3 Foundation walls. Foundation walls shall comply with the requirements of Section 2109.5.3.1 or 2109.5.3.2.

2109.5.3.1 Minimum thickness. Minimum thickness for foundation walls shall comply with the requirements of Table 2109.5.3.1. The provisions of Table 2109.5.3.1 are only applicable where the following conditions are met:

1. The foundation wall does not exceed 8 feet (2438 mm) in height between lateral supports;
2. The terrain surrounding foundation walls is graded to drain surface water away from foundation walls;
3. Backfill is drained to remove ground water away from foundation walls;
4. Lateral support is provided at the top of foundation walls prior to backfilling;
5. The length of foundation walls between perpendicular masonry walls or pilasters is a maximum of three times the basement wall height;
6. The backfill is granular and soil conditions in the area are nonexpansive; and
7. Masonry is laid in running bond using Type M or S mortar.

TABLE 2109.3.2
ALLOWABLE COMPRESSIVE STRESSES FOR EMPIRICAL DESIGN OF MASONRY

CONSTRUCTION; COMPRESSIVE STRENGTH OF UNIT GROSS AREA (psi)	ALLOWABLE COMPRESSIVE STRESSES[a] GROSS CROSS-SECTIONAL AREA (psi)	
	Type M or S mortar	Type N mortar
Solid masonry of brick and other solid units of clay or shale; sand-lime or concrete brick:		
8,000 or greater	350	300
4,500	225	200
2,500	160	140
1,500	115	100
Grouted masonry, of clay or shale; sand-lime or concrete:		
4,500 or greater	225	200
2,500	160	140
1,500	115	100
Solid masonry of solid concrete masonry units:		
3,000 or greater	225	200
2,000	160	140
1,200	115	100
Masonry of hollow load-bearing units:		
2,000 or greater	140	120
1,500	115	100
1,000	75	70
700	60	55
Hollow walls (noncomposite masonry bonded)[b]		
Solid units:		
2,500 or greater	160	140
1,500	115	100
Hollow units	75	70
Stone ashlar masonry:		
Granite	720	640
Limestone or marble	450	400
Sandstone or cast stone	360	320
Rubble stone masonry		
Coursed, rough or random	120	100

For SI: 1 pound per square inch = 0.006895 MPa.

a. Linear interpolation for determining allowable stresses for masonry units having compressive strengths which are intermediate between those given in the table is permitted.

b. Where floor and roof loads are carried upon one wythe, the gross cross-sectional area is that of the wythe under load; if both wythes are loaded, the gross cross-sectional area is that of the wall minus the area of the cavity between the wythes. Walls bonded with metal ties shall be considered as noncomposite walls unless collar joints are filled with mortar or grout.

TABLE 2109.5.3.1
FOUNDATION WALL CONSTRUCTION

WALL CONSTRUCTION	NOMINAL WALL THICKNESS (inches)	MAXIMUM DEPTH OF UNBALANCED BACKFILL (feet)
Fully grouted masonry	8 10 12	7 8 8
Hollow unit masonry	8 10 12	5 6 7
Solid unit masonry	8 10 12	5 7 7

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

2109.5.3.2 Design requirements. Where the requirements of Section 2109.5.3.1 are not met, foundation walls shall be designed in accordance with Section 1805.5.

2109.5.4 Parapet walls.

2109.5.4.1 Minimum thickness. The minimum thickness of unreinforced masonry parapets shall meet Section 2109.5.2.6 and their height shall not exceed three times their thickness.

2109.5.4.2 Additional provisions. Additional provisions for parapet walls are contained in Sections 1503.2 and 1503.3.

2109.6 Bond.

2109.6.1 General. The facing and backing of multiwythe masonry walls shall be bonded in accordance with Section 2109.6.2, 2109.6.3 or 2109.6.4.

2109.6.2 Bonding with masonry headers.

2109.6.2.1 Solid units. Where the facing and backing (adjacent wythes) of solid masonry construction are bonded by means of masonry headers, no less than 4 percent of the wall surface of each face shall be composed of headers extending not less than 3 inches (76 mm) into the backing. The distance between adjacent full-length headers shall not exceed 24 inches (610 mm) either vertically or horizontally. In walls in which a single header does not extend through the wall, headers from the opposite sides shall overlap at least 3 inches (76 mm), or headers from opposite sides shall be covered with another header course overlapping the header below at least 3 inches (76 mm).

2109.6.2.2 Hollow units. Where two or more hollow units are used to make up the thickness of a wall, the stretcher courses shall be bonded at vertical intervals not exceeding 34 inches (864 mm) by lapping at least 3 inches (76 mm) over the unit below, or by lapping at vertical intervals not exceeding 17 inches (432 mm) with units that are at least 50 percent greater in thickness than the units below.

2109.6.2.3 Masonry bonded hollow walls. In masonry bonded hollow walls, the facing and backing shall be bonded so that not less than 4 percent of the wall surface of each face is composed of masonry bonded units extending not less than 3 inches (76 mm) into the backing. The distance between adjacent bonders shall not exceed 24 inches (610 mm) either vertically or horizontally.

2109.6.3 Bonding with wall ties or joint reinforcement.

2109.6.3.1 Bonding with wall ties. Except as required by Section 2109.6.3.1.1, where the facing and backing (adjacent wythes) of masonry walls are bonded with wire size W2.8 (MW18) wall ties or metal wire of equivalent stiffness embedded in the horizontal mortar joints, there shall be at least one metal tie for each $4^1/_2$ square feet (0.42 m^2) of wall area. The maximum vertical distance between ties shall not exceed 24 inches (610 mm), and the maximum horizontal distance shall not exceed 36 inches (914 mm). Rods or ties bent to rectangular shape shall be used with hollow masonry units laid with the cells vertical. In other walls, the ends of ties shall be bent to 90-degree (1.57 rad) angles to provide hooks no less than 2 inches (51 mm) long. Wall ties shall be without drips. Additional bonding ties shall be provided at all openings, spaced not more than 36 inches (914 mm) apart around the perimeter and within 12 inches (305 mm) of the opening.

2109.6.3.1.1 Bonding with adjustable wall ties. Where the facing and backing (adjacent wythes) of masonry are bonded with adjustable wall ties, there shall be at least one tie for each 1.77 square feet (0.164 m^2) of wall area. Neither the vertical nor horizontal spacing of the adjustable wall ties shall exceed 16 inches (406 mm). The maximum vertical offset of bed joints from one wythe to the other shall be $1^1/_4$ inches (32 mm). The maximum clearance between connecting parts of the ties shall be $^1/_{16}$ inch (1.6 mm). When pintle legs are used, ties shall have at least two wire size W2.8 (MW18) legs.

2109.6.3.2 Bonding with prefabricated joint reinforcement. Where the facing and backing (adjacent wythes) of masonry are bonded with prefabricated joint reinforcement, there shall be at least one cross wire serving as a tie for each $2^2/_3$ square feet (0.25 m^2) of wall area. The vertical spacing of the joint reinforcing shall not exceed 24 inches (610 mm). Cross wires on prefabricated joint reinforcement shall not be less than W1.7 (MW11) and shall be without drips. The longitudinal wires shall be embedded in the mortar.

2109.6.4 Bonding with natural or cast stone.

2109.6.4.1 Ashlar masonry. In ashlar masonry, bonder units, uniformly distributed, shall be provided to the extent of not less than 10 percent of the wall area. Such bonder units shall extend not less than 4 inches (102 mm) into the backing wall.

2109.6.4.2 Rubble stone masonry. Rubble stone masonry 24 inches (610 mm) or less in thickness shall have bonder units with a maximum spacing of 36 inches (914 mm) vertically and 36 inches (914 mm) horizontally, and if the masonry is of greater thickness than 24 inches (610 mm), shall have one bonder unit for each 6 square feet (0.56 m^2) of wall surface on both sides.

2109.6.5 Masonry bonding pattern.

2109.6.5.1 Masonry laid in running bond. Each wythe of masonry shall be laid in running bond, head joints in successive courses shall be offset by not less than one-fourth the unit length or the masonry walls shall be reinforced longitudinally as required in Section 2109.6.5.2.

2109.6.5.2 Masonry laid in stack bond. Where unit masonry is laid with less head joint offset than in Section 2109.6.5.1, the minimum area of horizontal reinforcement placed in mortar bed joints or in bond beams spaced not more than 48 inches (1219 mm) apart, shall be 0.0003 times the vertical cross-sectional area of the wall.

2109.7 Anchorage.

2109.7.1 General. Masonry elements shall be anchored in accordance with Sections 2109.7.2 through 2109.7.4.

2109.7.2 Intersecting walls. Masonry walls depending upon one another for lateral support shall be anchored or bonded at locations where they meet or intersect by one of the methods indicated in Sections 2109.7.2.1 through 2109.7.2.5.

2109.7.2.1 Bonding pattern. Fifty percent of the units at the intersection shall be laid in an overlapping masonry bonding pattern, with alternate units having a bearing of not less than 3 inches (76 mm) on the unit below.

2109.7.2.2 Steel connectors. Walls shall be anchored by steel connectors having a minimum section of $^1/_4$ inch (6.4 mm) by $1^1/_2$ inches (38 mm), with ends bent up at least 2 inches (51 mm) or with cross pins to form anchorage. Such anchors shall be at least 24 inches (610 mm) long and the maximum spacing shall be 48 inches (1219 mm).

2109.7.2.3 Joint reinforcement. Walls shall be anchored by joint reinforcement spaced at a maximum distance of 8 inches (203 mm). Longitudinal wires of such reinforcement shall be at least wire size W1.7 (MW 11) and shall extend at least 30 inches (762 mm) in each direction at the intersection.

2109.7.2.4 Interior nonload-bearing walls. Interior nonload-bearing walls shall be anchored at their intersection, at vertical intervals of not more than 16 inches (406 mm) with joint reinforcement or $^1/_4$-inch (6.4 mm) mesh galvanized hardware cloth.

2109.7.2.5 Ties, joint reinforcement or anchors. Other metal ties, joint reinforcement or anchors, if used, shall be spaced to provide equivalent area of anchorage to that required by this section.

2109.7.3 Floor and roof anchorage. Floor and roof diaphragms providing lateral support to masonry shall comply with the live loads in Section 1607.3 and shall be connected to the masonry in accordance with Sections 2109.7.3.1 through 2109.7.3.3. Roof loading shall be determined in accordance with Chapter 16 and, when net uplift occurs, uplift shall be resisted entirely by an anchorage system designed in accordance with the provisions of Sections 2.1 and 2.3, Sections 3.1 and 3.3 or Chapter 4 of ACI 530/ASCE 5/TMS 402.

2109.7.3.1 Wood floor joists. Wood floor joists bearing on masonry walls shall be anchored to the wall at intervals not to exceed 72 inches (1829 mm) by metal strap anchors. Joists parallel to the wall shall be anchored with metal straps spaced not more than 72 inches (1829 mm) o.c. extending over or under and secured to at least three joists. Blocking shall be provided between joists at each strap anchor.

2109.7.3.2 Steel floor joists. Steel floor joists bearing on masonry walls shall be anchored to the wall with $^3/_8$-inch (9.5 mm) round bars, or their equivalent, spaced not more than 72 inches (1829 mm) o.c. Where joists are parallel to the wall, anchors shall be located at joist bridging.

2109.7.3.3 Roof diaphragms. Roof diaphragms shall be anchored to masonry walls with $^1/_2$-inch-diameter (12.7 mm) bolts, 72 inches (1829 mm) o.c. or their equivalent. Bolts shall extend and be embedded at least 15 inches (381 mm) into the masonry, or be hooked or welded to not less than 0.20 square inch (129 mm^2) of bond beam reinforcement placed not less than 6 inches (152 mm) from the top of the wall.

2109.7.4 Walls adjoining structural framing. Where walls are dependent upon the structural frame for lateral support, they shall be anchored to the structural members with metal anchors or otherwise keyed to the structural members. Metal anchors shall consist of $^1/_2$-inch (12.7 mm) bolts spaced at 48 inches (1219 mm) o.c. embedded 4 inches (102 mm) into the masonry, or their equivalent area.

2109.8 Adobe construction. Adobe construction shall comply with this section and shall be subject to the requirements of this code for Type V construction.

2109.8.1 Unstabilized adobe.

2109.8.1.1 Compressive strength. Adobe units shall have an average compressive strength of 300 psi (2068 kPa) when tested in accordance with ASTM C 67. Five samples shall be tested and no individual unit is permitted to have a compressive strength of less than 250 psi (1724 kPa).

2109.8.1.2 Modulus of rupture. Adobe units shall have an average modulus of rupture of 50 psi (345 kPa) when tested in accordance with the following procedure. Five samples shall be tested and no individual unit shall have a modulus of rupture of less than 35 psi (241 kPa).

2109.8.1.2.1 Support conditions. A cured unit shall be simply supported by 2-inch-diameter (51 mm) cylindrical supports located 2 inches (51 mm) in from each end and extending the full width of the unit.

2109.8.1.2.2 Loading conditions. A 2-inch-diameter (51 mm) cylinder shall be placed at midspan parallel to the supports.

2109.8.1.2.3 Testing procedure. A vertical load shall be applied to the cylinder at the rate of 500 pounds per minute (37 N/s) until failure occurs.

2109.8.1.2.4 Modulus of rupture determination. The modulus of rupture shall be determined by the equation:

$$f_r = 3WL_s/2bt^2 \qquad \textbf{(Equation 21-4)}$$

where, for the purposes of this section only:

b = Width of the test specimen measured parallel to the loading cylinder, inches (mm).

f_r = Modulus of rupture, psi (MPa).

L_s = Distance between supports, inches (mm).

t = Thickness of the test specimen measured parallel to the direction of load, inches (mm).

W = The applied load at failure, pounds (N).

2109.8.1.3 Moisture content requirements. Adobe units shall have a moisture content not exceeding 4 percent by weight.

2109.8.1.4 Shrinkage cracks. Adobe units shall not contain more than three shrinkage cracks and any single shrinkage crack shall not exceed 3 inches (76 mm) in length or $^1/_8$ inch (3.2 mm) in width.

2109.8.2 Stabilized adobe.

2109.8.2.1 Material requirements. Stabilized adobe shall comply with the material requirements of unstabilized adobe in addition to Sections 2109.8.2.1.1 and 2109.8.2.1.2.

2109.8.2.1.1 Soil requirements. Soil used for stabilized adobe units shall be chemically compatible with the stabilizing material.

2109.8.2.1.2 Absorption requirements. A 4-inch (102 mm) cube, cut from a stabilized adobe unit dried to a constant weight in a ventilated oven at 212°F to 239°F (100°C to 115°C), shall not absorb more than $2^1/_2$ percent moisture by weight when placed upon a constantly water-saturated, porous surface for seven days. A minimum of five specimens shall be tested and each specimen shall be cut from a separate unit.

2109.8.3 Allowable stress. The allowable compressive stress based on gross cross-sectional area of adobe shall not exceed 30 psi (207 kPa).

2109.8.3.1 Bolts. Bolt values shall not exceed those set forth in Table 2109.8.3.1.

TABLE 2109.8.3.1
ALLOWABLE SHEAR ON BOLTS IN ADOBE MASONRY

DIAMETER OF BOLTS (inches)	MINIMUM EMBEDMENT (inches)	SHEAR (pounds)
$^1/_2$	—	—
$^5/_8$	12	200
$^3/_4$	15	300
$^7/_8$	18	400
1	21	500
$1^1/_8$	24	600

For SI: 1 inch = 25.4 mm, 1 pound = 4.448 N.

2109.8.4 Construction.

2109.8.4.1 General.

2109.8.4.1.1 Height restrictions. Adobe construction shall be limited to buildings not exceeding one story, except that two-story construction is allowed when designed by a registered design professional.

2109.8.4.1.2 Mortar restrictions. Mortar for stabilized adobe units shall comply with Chapter 21 or adobe soil. Adobe soil used as mortar shall comply with material requirements for stabilized adobe. Mortar for unstabilized adobe shall be portland cement mortar.

2109.8.4.1.3 Mortar joints. Adobe units shall be laid with full head and bed joints and in full running bond.

2109.8.4.1.4 Parapet walls. Parapet walls constructed of adobe units shall be waterproofed.

2109.8.4.2 Wall thickness. The minimum thickness of exterior walls in one-story buildings shall be 10 inches (254 mm). The walls shall be laterally supported at intervals not exceeding 24 feet (7315 mm). The minimum thickness of interior load-bearing walls shall be 8 inches (203 mm). In no case shall the unsupported height of any wall constructed of adobe units exceed 10 times the thickness of such wall.

2109.8.4.3 Foundations.

2109.8.4.3.1 Foundation support. Walls and partitions constructed of adobe units shall be supported by foundations or footings that extend not less than 6 inches (152 mm) above adjacent ground surfaces and are constructed of solid masonry (excluding adobe) or concrete. Footings and foundations shall comply with Chapter 18.

2109.8.4.3.2 Lower course requirements. Stabilized adobe units shall be used in adobe walls for the first 4 inches (102 mm) above the finished first-floor elevation.

2109.8.4.4 Isolated piers or columns. Adobe units shall not be used for isolated piers or columns in a load-bearing capacity. Walls less than 24 inches (610 mm) in length shall be considered isolated piers or columns.

2109.8.4.5 Tie beams. Exterior walls and interior load-bearing walls constructed of adobe units shall have a continuous tie beam at the level of the floor or roof bearing and meeting the following requirements.

2109.8.4.5.1 Concrete tie beams. Concrete tie beams shall be a minimum depth of 6 inches (152 mm) and a minimum width of 10 inches (254 mm). Concrete tie beams shall be continuously reinforced with a minimum of two No. 4 reinforcing bars. The ultimate compressive strength of concrete shall be at least 2,500 psi (17.2 MPa) at 28 days.

2109.8.4.5.2 Wood tie beams. Wood tie beams shall be solid or built up of lumber having a minimum nominal thickness of 1 inch (25 mm), and shall have a minimum depth of 6 inches (152 mm) and a minimum width of 10 inches (254 mm). Joints in wood tie beams shall be spliced a minimum of 6 inches (152 mm). No splices shall be allowed within 12 inches (305 mm) of an opening. Wood used in tie beams shall be approved naturally decay-resistant or pressure-treated wood.

2109.8.4.6 Exterior finish. Exterior walls constructed of unstabilized adobe units shall have their exterior surface covered with a minimum of two coats of portland cement plaster having a minimum thickness of $^3/_4$ inch (19.1 mm) and conforming to ASTM C 926. Lathing shall comply with ASTM C 1063. Fasteners shall be spaced at 16 inches (406 mm) o.c. maximum. Exposed wood surfaces shall be treated with an approved wood preservative or other protective coating prior to lath application.

2109.8.4.7 Lintels. Lintels shall be considered structural members and shall be designed in accordance with the applicable provisions of Chapter 16.

SECTION 2110 GLASS UNIT MASONRY

2110.1 Scope. This section covers the empirical requirements for nonload-bearing glass unit masonry elements in exterior or interior walls.

2110.1.1 Limitations. Solid or hollow approved glass block shall not be used in fire walls, party walls, fire barriers or fire partitions, or for load-bearing construction. Such blocks shall be erected with mortar and reinforcement in metal channel-type frames, structural frames, masonry or concrete recesses, embedded panel anchors as provided for both exterior and interior walls or other approved joint materials. Wood strip framing shall not be used in walls required to have a fire-resistance rating by other provisions of this code.

Exceptions:

1. Glass-block assemblies having a fire protection rating of not less than $^3/_4$ hour shall be permitted as opening protectives in accordance with Section 715 in fire barriers and fire partitions that have a required fire-resistance rating of 1 hour or less and do not enclose exit stairways or exit passageways.
2. Glass-block assemblies as permitted in Section 404.5, Exception 2.
3. Fire tested and listed glass unit masonry shall be permitted for use in accordance with its listing.

2110.2 Units. Hollow or solid glass-block units shall be standard or thin units.

2110.2.1 Standard units. The specified thickness of standard units shall be at least 3 $^7/_8$ inches (98 mm).

2110.2.2 Thin units. The specified thickness of thin units shall be 3 $^1/_8$ inches (79 mm) for hollow units or 3 inches (76 mm) for solid units.

2110.3 Panel size.

2110.3.1 Exterior standard-unit panels. The maximum area of each individual exterior standard-unit panel shall be 144 square feet (13.4 m^2) when the design wind pressure is 20 psf (958 N/m^2). The maximum panel dimension between structural supports shall be 25 feet (7620 mm) in width or 20 feet (6096 mm) in height. The panel areas are permitted to be adjusted in accordance with Figure 2110.3.1 for other wind pressures.

2110.3.2 Exterior thin-unit panels. The maximum area of each individual exterior thin-unit panel shall be 85 square feet (7.9 m^2). The maximum dimension between structural supports shall be 15 feet (4572 mm) in width or 10 feet (3048 mm) in height. Thin units shall not be used in applications where the design wind pressure exceeds 20 psf (958 N/m^2).

2110.3.3 Interior panels. The maximum area of each individual standard-unit panel shall be 250 square feet (23.2 m^2). The maximum area of each thin-unit panel shall be 150 square feet (13.9 m^2). The maximum dimension between structural supports shall be 25 feet (7620 mm) in width or 20 feet (6096 mm) in height.

2110.3.4 Solid units. The maximum area of solid glass-block wall panels in both exterior and interior walls shall not be more than 100 square feet (9.3 m^2).

2110.3.5 Curved panels. The width of curved panels shall conform to the requirements of Sections 2110.3.1, 2110.3.2 and 2110.3.3, except additional structural supports shall be provided at locations where a curved section joins a straight section, and at inflection points in multicurved walls.

2110.4 Support.

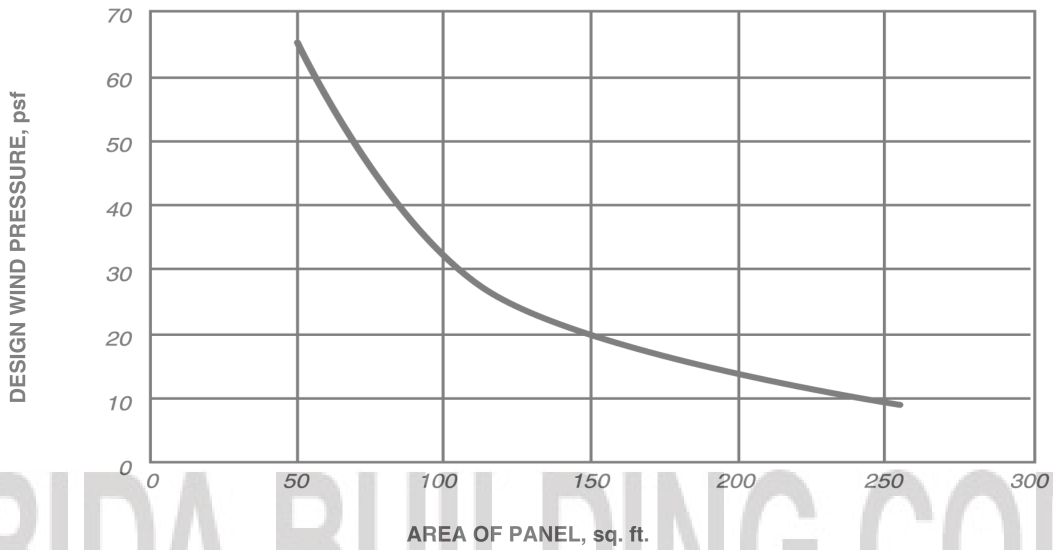
2110.4.1 General requirements. Glass unit masonry panels shall be isolated so that in-plane loads are not imparted to the panel.

2110.4.2 Vertical. Maximum total deflection of structural members supporting glass unit masonry shall not exceed $^l/_{600}$.

2110.4.2.1 Support on wood construction. Glass unit masonry having an installed weight of 40 psf (195 kg/m^2) or less and a maximum height of 12 feet (3658 mm) shall be permitted to be supported on wood construction.

2110.4.2.2 Expansion joint. A vertical expansion joint in glass unit masonry shall be provided to isolate the glass unit masonry supported by wood construction from that supported by other types of construction.

2110.4.3 Lateral. Glass unit masonry panels more than one unit wide or one unit high shall be laterally supported along their tops and sides. Lateral support shall be provided by panel anchors along the top and sides spaced not more than 16 inches (406 mm) o.c. or by channel-type restraints. Glass unit masonry panels shall be recessed at least 1 inch (25 mm) within channels and chases. Channel-type restraints shall be oversized to accommodate expansion material in the opening and packing and sealant between the framing restraints and the glass unit masonry perimeter units. Lateral supports for glass unit masonry panels shall be designed to



For SI: 1 square foot = 0.0929 m^2, 1 pound per square foot = 47.9 N/m^2.

FIGURE 2110.3.1
GLASS MASONRY DESIGN WIND LOAD RESISTANCE

resist applied loads, or a minimum of 200 pounds per lineal feet (plf) (2919 N/m) of panel, whichever is greater.

Exceptions:

1. Lateral support at the top of glass unit masonry panels that are no more than one unit wide shall not be required.
2. Lateral support at the sides of glass unit masonry panels that are no more than one unit high shall not be required.

2110.4.3.1 Single unit panels. Single unit glass unit masonry panels shall conform to the requirements of Section 2110.4.3, except lateral support shall not be provided by panel anchors.

2110.5 Expansion joints. Glass unit masonry panels shall be provided with expansion joints along the top and sides at structural supports. Expansion joints shall have sufficient thickness to accommodate displacements of the supporting structure, but shall not be less than $^3/_8$ inch (9.5 mm) in thickness. Expansion joints shall be entirely free of mortar or other debris and shall be filled with resilient material. The sills of glass-block panels shall be coated with approved water-based asphaltic emulsion, or other elastic waterproofing material, prior to laying the first mortar course.

2110.6 Mortar. Mortar for glass unit masonry shall comply with Section 2103.8.

2110.7 Reinforcement. Glass unit masonry panels shall have horizontal joint reinforcement spaced not more than 16 inches (406 mm) on center, located in the mortar bed joint, and extending the entire length of the panel but not across expansion joints. Longitudinal wires shall be lapped a minimum of 6 inches (152 mm) at splices. Joint reinforcement shall be placed in the bed joint immediately below and above openings in the panel. The reinforcement shall have not less than two parallel longitudinal wires of size W1.7 (MW11), and have welded cross wires of size W1.7 (MW11).

SECTION 2111
MASONRY FIREPLACES

2111.1 Definition. A masonry fireplace is a fireplace constructed of concrete or masonry. Masonry fireplaces shall be constructed in accordance with this section.

2111.2 Footings and foundations. Footings for masonry fireplaces and their chimneys shall be constructed of concrete or solid masonry at least 12 inches (305 mm) thick and shall extend at least 6 inches (153 mm) beyond the face of the fireplace or foundation wall on all sides. Footings shall be founded on natural undisturbed earth or engineered fill below frost depth. In areas not subjected to freezing, footings shall be at least 12 inches (305 mm) below finished grade.

2111.2.1 Ash dump cleanout. Cleanout openings, located within foundation walls below fireboxes, when provided, shall be equipped with ferrous metal or masonry doors and frames constructed to remain tightly closed, except when in use. Cleanouts shall be accessible and located so that ash removal will not create a hazard to combustible materials.

2111.3 Seismic reinforcing. Reserved.

2111.4 Seismic anchorage. Reserved.

2111.5 Firebox walls. Masonry fireboxes shall be constructed of solid masonry units, hollow masonry units grouted solid, stone or concrete. When a lining of firebrick at least 2 inches (51 mm) in thickness or other approved lining is provided, the minimum thickness of back and sidewalls shall each be 8 inches (203 mm) of solid masonry, including the lining. The width of joints between firebricks shall not be greater than $^{1}/_{4}$ inch (6.4 mm). When no lining is provided, the total minimum thickness of back and sidewalls shall be 10 inches (254 mm) of solid masonry. Firebrick shall conform to ASTM C 27 or ASTM C 1261 and shall be laid with medium-duty refractory mortar conforming to ASTM C 199.

2111.5.1 Steel fireplace units. Steel fireplace units are permitted to be installed with solid masonry to form a masonry fireplace provided they are installed according to either the requirements of their listing or the requirements of this section. Steel fireplace units incorporating a steel firebox lining shall be constructed with steel not less than $^{1}/_{4}$ inch (6.4 mm) in thickness, and an air-circulating chamber which is ducted to the interior of the building. The firebox lining shall be encased with solid masonry to provide a total thickness at the back and sides of not less than 8 inches (203 mm), of which not less than 4 inches (102 mm) shall be of solid masonry or concrete. Circulating air ducts employed with steel fireplace units shall be constructed of metal or masonry.

2111.6 Firebox dimensions. The firebox of a concrete or masonry fireplace shall have a minimum depth of 20 inches (508 mm). The throat shall not be less than 8 inches (203 mm) above the fireplace opening. The throat opening shall not be less than 4 inches (102 mm) in depth. The cross-sectional area of the passageway above the firebox, including the throat, damper and smoke chamber, shall not be less than the cross-sectional area of the flue.

Exception: Rumford fireplaces shall be permitted provided that the depth of the fireplace is at least 12 inches (305 mm) and at least one-third of the width of the fireplace opening, and the throat is at least 12 inches (305 mm) above the lintel, and at least $^{1}/_{20}$ the cross-sectional area of the fireplace opening.

2111.7 Lintel and throat. Masonry over a fireplace opening shall be supported by a lintel of noncombustible material. The minimum required bearing length on each end of the fireplace opening shall be 4 inches (102 mm). The fireplace throat or damper shall be located a minimum of 8 inches (203 mm) above the top of the fireplace opening.

2111.7.1 Damper. Masonry fireplaces shall be equipped with a ferrous metal damper located at least 8 inches (203 mm) above the top of the fireplace opening. Dampers shall be installed in the fireplace or at the top of the flue venting the fireplace, and shall be operable from the room containing the fireplace. Damper controls shall be permitted to be located in the fireplace.

2111.8 Smoke chamber walls. Smoke chamber walls shall be constructed of solid masonry units, hollow masonry units grouted solid, stone or concrete. Corbeling of masonry units shall not leave unit cores exposed to the inside of the smoke chamber. The inside surface of corbeled masonry shall be parged smooth. Where no lining is provided, the total minimum thickness of front, back and sidewalls shall be 8 inches (203 mm) of solid masonry. When a lining of firebrick at least 2 inches (51 mm) thick, or a lining of vitrified clay at least $^{5}/_{8}$ inch (15.9 mm) thick, is provided, the total minimum thickness of front, back and sidewalls shall be 6 inches (152 mm) of solid masonry, including the lining. Firebrick shall conform to ASTM C 27 or ASTM C 1261 and shall be laid with refractory mortar conforming to ASTM C 199.

2111.8.1 Smoke chamber dimensions. The inside height of the smoke chamber from the fireplace throat to the beginning of the flue shall not be greater than the inside width of the fireplace opening. The inside surface of the smoke chamber shall not be inclined more than 45 degrees (0.76 rad) from vertical when prefabricated smoke chamber linings are used or when the smoke chamber walls are rolled or sloped rather than corbeled. When the inside surface of the smoke chamber is formed by corbeled masonry, the walls shall not be corbeled more than 30 degrees (0.52 rad) from vertical.

2111.9 Hearth and hearth extension. Masonry fireplace hearths and hearth extensions shall be constructed of concrete or masonry, supported by noncombustible materials, and reinforced to carry their own weight and all imposed loads. No combustible material shall remain against the underside of hearths or hearth extensions after construction.

2111.9.1 Hearth thickness. The minimum thickness of fireplace hearths shall be 4 inches (102 mm).

2111.9.2 Hearth extension thickness. The minimum thickness of hearth extensions shall be 2 inches (51 mm).

Exception: When the bottom of the firebox opening is raised at least 8 inches (203 mm) above the top of the hearth extension, a hearth extension of not less than $^{3}/_{8}$-inch-thick (9.5 mm) brick, concrete, stone, tile or other approved noncombustible material is permitted.

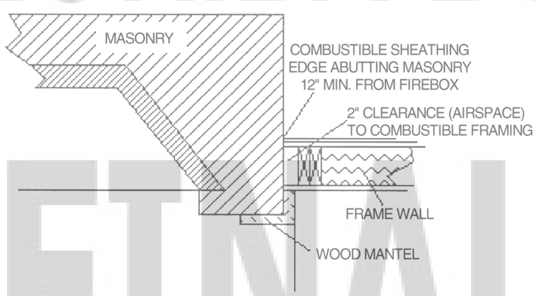
2111.10 Hearth extension dimensions. Hearth extensions shall extend at least 16 inches (406 mm) in front of, and at least 8 inches (203 mm) beyond, each side of the fireplace opening. Where the fireplace opening is 6 square feet (0.557 m^2) or larger, the hearth extension shall extend at least 20 inches (508 mm) in front of, and at least 12 inches (305 mm) beyond, each side of the fireplace opening.

2111.11 Fireplace clearance. Any portion of a masonry fireplace located in the interior of a building or within the exterior wall of a building shall have a clearance to combustibles of not less than 2 inches (51 mm) from the front faces and sides of masonry fireplaces and not less than 4 inches (102 mm) from the back faces of masonry fireplaces. The airspace shall not be filled, except to provide fireblocking in accordance with Section 2111.12.

Exceptions:

1. Masonry fireplaces listed and labeled for use in contact with combustibles in accordance with UL 127 and installed in accordance with the manufacturer's installation instructions are permitted to have combustible material in contact with their exterior surfaces.
2. When masonry fireplaces are constructed as part of masonry or concrete walls, combustible materials shall not be in contact with the masonry or concrete walls less than 12 inches (306 mm) from the inside surface of the nearest firebox lining.

3. Exposed combustible trim and the edges of sheathing materials, such as wood siding, flooring and drywall, are permitted to abut the masonry fireplace sidewalls and hearth extension, in accordance with Figure 2111.11, provided such combustible trim or sheathing is a minimum of 12 inches (306 mm) from the inside surface of the nearest firebox lining.
4. Exposed combustible mantels or trim is permitted to be placed directly on the masonry fireplace front surrounding the fireplace opening, provided such combustible materials shall not be placed within 6 inches (153 mm) of a fireplace opening. Combustible material directly above and within 12 inches (305 mm) of the fireplace opening shall not project more than $^1/_8$ inch (3.2 mm) for each 1-inch (25 mm) distance from such opening. Combustible materials located along the sides of the fireplace opening that project more than $1^1/_2$ inches (38 mm) from the face of the fireplace shall have an additional clearance equal to the projection.



For SI: 1 inch = 25.4 mm

FIGURE 2111.11
ILLUSTRATION OF EXCEPTION TO FIREPLACE CLEARANCE PROVISION

2111.12 Fireplace fireblocking. All spaces between fireplaces and floors and ceilings through which fireplaces pass shall be fireblocked with noncombustible material securely fastened in place. The fireblocking of spaces between wood joists, beams or headers shall be to a depth of 1 inch (25 mm) and shall only be placed on strips of metal or metal lath laid across the spaces between combustible material and the chimney.

2111.13 Exterior air. Factory-built or masonry fireplaces covered in this section shall be equipped with an exterior air supply to ensure proper fuel combustion unless the room is mechanically ventilated and controlled so that the indoor pressure is neutral or positive.

2111.13.1 Factory-built fireplaces. Exterior combustion air ducts for factory-built fireplaces shall be listed components of the fireplace, and installed according to the fireplace manufacturer's instructions.

2111.13.2 Masonry fireplaces. Listed combustion air ducts for masonry fireplaces shall be installed according to the terms of their listing and manufacturer's instructions.

2111.13.3 Exterior air intake. The exterior air intake shall be capable of providing all combustion air from the exterior of the dwelling. The exterior air intake shall not be located within the garage, attic, basement or crawl space of the dwelling nor shall the air intake be located at an elevation higher than the firebox. The exterior air intake shall be covered with a corrosion-resistant screen of $^1/_4$-inch (6.4 mm) mesh.

2111.13.4 Clearance. Unlisted combustion air ducts shall be installed with a minimum 1-inch (25 mm) clearance to combustibles for all parts of the duct within 5 feet (1524 mm) of the duct outlet.

2111.13.5 Passageway. The combustion air passageway shall be a minimum of 6 square inches (3870 mm^2) and not more than 55 square inches (0.035 m^2), except that combustion air systems for listed fireplaces or for fireplaces tested for emissions shall be constructed according to the fireplace manufacturer's instructions.

2111.13.6 Outlet. The exterior air outlet is permitted to be located in the back or sides of the firebox chamber or within 24 inches (610 mm) of the firebox opening on or near the floor. The outlet shall be closable and designed to prevent burning material from dropping into concealed combustible spaces.

SECTION 2112
MASONRY HEATERS

2112.1 Definition. A masonry heater is a heating appliance constructed of concrete or solid masonry, hereinafter referred to as "masonry," which is designed to absorb and store heat from a solid fuel fire built in the firebox by routing the exhaust gases through internal heat exchange channels in which the flow path downstream of the firebox may include flow in a horizontal or downward direction before entering the chimney and which delivers heat by radiation from the masonry surface of the heater.

2112.2 Installation. Masonry heaters shall be installed in accordance with this section and comply with one of the following:

1. Masonry heaters shall comply with the requirements of ASTM E 1602; or
2. Masonry heaters shall be listed and labeled in accordance with UL 1482 and installed in accordance with the manufacturer's installation instructions.

2112.3 Footings and foundation. The firebox floor of a masonry heater shall be a minimum thickness of 4 inches (102 mm) of noncombustible material and be supported on a noncombustible footing and foundation in accordance with Section 2113.2.

2112.4 Seismic reinforcing. Reserved.

2112.5 Masonry heater clearance. Combustible materials shall not be placed within 36 inches (765 mm) of the outside surface of a masonry heater in accordance with NFPA 211, Section 8-7 (clearances for solid fuel-burning appliances), and the required space between the heater and combustible material shall be fully vented to permit the free flow of air around all heater surfaces.

Exceptions:

1. When the masonry heater wall thickness is at least 8 inches (203 mm) thick of solid masonry and the wall thickness of the heat exchange channels is at least 5 inches (127 mm) thick of solid masonry, combustible materials shall not be placed within 4 inches (102 mm) of the outside surface of a masonry heater. A clearance of at least 8 inches (203 mm) shall be provided between the gas-tight capping slab of the heater and a combustible ceiling.
2. Masonry heaters listed and labeled in accordance with UL 1482 and installed in accordance with the manufacturer's instructions.

SECTION 2113 MASONRY CHIMNEYS

2113.1 Definition. A masonry chimney is a chimney constructed of concrete or masonry, hereinafter referred to as "masonry." Masonry chimneys shall be constructed, anchored, supported and reinforced as required in this chapter.

2113.2 Footings and foundations. Footings for masonry chimneys shall be constructed of concrete or solid masonry at least 12 inches (305 mm) thick and shall extend at least 6 inches (152 mm) beyond the face of the foundation or support wall on all sides. Footings shall be founded on natural undisturbed earth or engineered fill below frost depth. In areas not subjected to freezing, footings shall be at least 12 inches (305 mm) below finished grade.

2113.3 Seismic reinforcing. Reserved.

2113.3.1 Vertical reinforcing. Reserved.

2113.3.2 Horizontal reinforcing. Reserved.

2113.4 Seismic anchorage. Reserved.

2113.4.1 Anchorage. Reserved.

2113.5 Corbeling. Masonry chimneys shall not be corbeled more than half of the chimney's wall thickness from a wall or foundation, nor shall a chimney be corbeled from a wall or foundation that is less than 12 inches (305 mm) in thickness unless it projects equally on each side of the wall, except that on the second story of a two-story dwelling, corbeling of chimneys on the exterior of the enclosing walls is permitted to equal the wall thickness. The projection of a single course shall not exceed one-half the unit height or one-third of the unit bed depth, whichever is less.

2113.6 Changes in dimension. The chimney wall or chimney flue lining shall not change in size or shape within 6 inches (152 mm) above or below where the chimney passes through floor components, ceiling components or roof components.

2113.7 Offsets. Where a masonry chimney is constructed with a fireclay flue liner surrounded by one wythe of masonry, the maximum offset shall be such that the centerline of the flue above the offset does not extend beyond the center of the chimney wall below the offset. Where the chimney offset is supported by masonry below the offset in an approved manner, the maximum offset limitations shall not apply. Each individual corbeled masonry course of the offset shall not exceed the projection limitations specified in Section 2113.5.

2113.8 Additional load. Chimneys shall not support loads other than their own weight unless they are designed and constructed to support the additional load. Masonry chimneys are permitted to be constructed as part of the masonry walls or concrete walls of the building.

2113.9 Termination. Chimneys shall extend at least 2 feet (610 mm) higher than any portion of the building within 10 feet (3048 mm), but shall not be less than 3 feet (914 mm) above the highest point where the chimney passes through the roof.

2113.9.1 Spark arrestors. Where a spark arrestor is installed on a masonry chimney, the spark arrestor shall meet all of the following requirements:

1. The net free area of the arrestor shall not be less than four times the net free area of the outlet of the chimney flue it serves.
2. The arrestor screen shall have heat and corrosion resistance equivalent to 19-gage galvanized steel or 24-gage stainless steel.
3. Openings shall not permit the passage of spheres having a diameter greater than $^1/_2$ inch (13 mm) nor block the passage of spheres having a diameter less than $^3/_8$ inch (11 mm).
4. The spark arrestor shall be accessible for cleaning and the screen or chimney cap shall be removable to allow for cleaning of the chimney flue.

2113.10 Wall thickness. Masonry chimney walls shall be constructed of concrete, solid masonry units or hollow masonry units grouted solid with not less than 4 inches (102 mm) nominal thickness.

2113.10.1 Masonry veneer chimneys. Where masonry is used as veneer for a framed chimney, through flashing and weep holes shall be provided as required by Chapter 14.

2113.11 Flue lining (material). Masonry chimneys shall be lined. The lining material shall be appropriate for the type of appliance connected, according to the terms of the appliance listing and the manufacturer's instructions.

2113.11.1 Residential-type appliances (general). Flue lining systems shall comply with one of the following:

1. Clay flue lining complying with the requirements of ASTM C 315, or equivalent.
2. Listed chimney lining systems complying with UL 1777.
3. Factory-built chimneys or chimney units listed for installation within masonry chimneys.
4. Other approved materials that will resist corrosion, erosion, softening or cracking from flue gases and condensate at temperatures up to 1,800°F (982°C).

2113.11.1.1 Flue linings for specific appliances. Flue linings other than those covered in Section 2113.11.1 intended for use with specific appliances shall comply with Sections 2113.11.1.2 through 2113.11.1.4 and Sections 2113.11.2 and 2113.11.3.

2113.11.1.2 Gas appliances. Flue lining systems for gas appliances shall be in accordance with the *Florida Building Code, Fuel Gas*.

2113.11.1.3 Pellet fuel-burning appliances. Flue lining and vent systems for use in masonry chimneys with pellet fuel-burning appliances shall be limited to flue lining systems complying with Section 2113.11.1 and pellet vents listed for installation within masonry chimneys (see Section 2113.11.1.5 for marking).

2113.11.1.4 Oil-fired appliances approved for use with L-vent. Flue lining and vent systems for use in masonry chimneys with oil-fired appliances approved for use with Type L vent shall be limited to flue lining systems complying with Section 2113.11.1 and listed chimney liners complying with UL 641 (see Section 2113.11.1.5 for marking).

2113.11.1.5 Notice of usage. When a flue is relined with a material not complying with Section 2113.11.1, the chimney shall be plainly and permanently identified by a label attached to a wall, ceiling or other conspicuous location adjacent to where the connector enters the chimney. The label shall include the following message or equivalent language: "This chimney is for use only with (type or category of appliance) that burns (type of fuel). Do not connect other types of appliances."

2113.11.2 Concrete and masonry chimneys for medium-heat appliances.

2113.11.2.1 General. Concrete and masonry chimneys for medium-heat appliances shall comply with Sections 2113.1 through 2113.5.

2113.11.2.2 Construction. Chimneys for medium-heat appliances shall be constructed of solid masonry units or of concrete with walls a minimum of 8 inches (203 mm) thick, or with stone masonry a minimum of 12 inches (305 mm) thick.

2113.11.2.3 Lining. Concrete and masonry chimneys shall be lined with an approved medium-duty refractory brick a minimum of $4^1/_2$ inches (114 mm) thick laid on the $4^1/_2$-inch bed (114 mm) in an approved medium-duty refractory mortar. The lining shall start 2 feet (610 mm) or more below the lowest chimney connector entrance. Chimneys terminating 25 feet (7620 mm) or less above a chimney connector entrance shall be lined to the top.

2113.11.2.4 Multiple passageway. Concrete and masonry chimneys containing more than one passageway shall have the liners separated by a minimum 4-inch-thick (102 mm) concrete or solid masonry wall.

2113.11.2.5 Termination height. Concrete and masonry chimneys for medium-heat appliances shall extend a minimum of 10 feet (3048 mm) higher than any portion of any building within 25 feet (7620 mm).

2113.11.2.6 Clearance. A minimum clearance of 4 inches (102 mm) shall be provided between the exterior surfaces of a concrete or masonry chimney for medium-heat appliances and combustible material.

2113.11.3 Concrete and masonry chimneys for high-heat appliances.

2113.11.3.1 General. Concrete and masonry chimneys for high-heat appliances shall comply with Sections 2113.1 through 2113.5.

2113.11.3.2 Construction. Chimneys for high-heat appliances shall be constructed with double walls of solid masonry units or of concrete, each wall to be a minimum of 8 inches (203 mm) thick with a minimum airspace of 2 inches (51 mm) between the walls.

2113.11.3.3 Lining. The inside of the interior wall shall be lined with an approved high-duty refractory brick, a minimum of $4^1/_2$ inches (114 mm) thick laid on the $4^1/_2$-inch bed (114 mm) in an approved high-duty refractory mortar. The lining shall start at the base of the chimney and extend continuously to the top.

2113.11.3.4 Termination height. Concrete and masonry chimneys for high-heat appliances shall extend a minimum of 20 feet (6096 mm) higher than any portion of any building within 50 feet (15 240 mm).

2113.11.3.5 Clearance. Concrete and masonry chimneys for high-heat appliances shall have approved clearance from buildings and structures to prevent overheating combustible materials, permit inspection and maintenance operations on the chimney and prevent danger of burns to persons.

2113.12 Clay flue lining (installation). Clay flue liners shall be installed in accordance with ASTM C 1283 and extend from a point not less than 8 inches (203 mm) below the lowest inlet or, in the case of fireplaces, from the top of the smoke chamber to a point above the enclosing walls. The lining shall be carried up vertically, with a maximum slope no greater than 30 degrees (0.52 rad) from the vertical.

Clay flue liners shall be laid in medium-duty refractory mortar conforming to ASTM C 199 with tight mortar joints left smooth on the inside and installed to maintain an air space or insulation not to exceed the thickness of the flue liner separating the flue liners from the interior face of the chimney masonry walls. Flue lining shall be supported on all sides. Only enough mortar shall be placed to make the joint and hold the liners in position.

2113.13 Additional requirements.

2113.13.1 Listed materials. Listed materials used as flue linings shall be installed in accordance with the terms of their listings and the manufacturer's instructions.

2113.13.2 Space around lining. The space surrounding a chimney lining system or vent installed within a masonry chimney shall not be used to vent any other appliance.

Exception: This shall not prevent the installation of a separate flue lining in accordance with the manufacturer's instructions.

2113.14 Multiple flues. When two or more flues are located in the same chimney, masonry wythes shall be built between adjacent flue linings. The masonry wythes shall be at least 4 inches (102 mm) thick and bonded into the walls of the chimney.

Exception: When venting only one appliance, two flues are permitted to adjoin each other in the same chimney with only the flue lining separation between them. The joints of the adjacent flue linings shall be staggered at least 4 inches (102 mm).

2113.15 Flue area (appliance). Chimney flues shall not be smaller in area than the area of the connector from the appliance. Chimney flues connected to more than one appliance shall not be less than the area of the largest connector plus 50 percent of the areas of additional chimney connectors.

Exceptions:

1. Chimney flues serving oil-fired appliances sized in accordance with NFPA 31.
2. Chimney flues serving gas-fired appliances sized in accordance with the *Florida Building Code, Fuel Gas*.

2113.16 Flue area (masonry fireplace). Flue sizing for chimneys serving fireplaces shall be in accordance with Section 2113.16.1 or 2113.16.2.

2113.16.1 Minimum area. Round chimney flues shall have a minimum net cross-sectional area of at least $^1/_{12}$ of the fireplace opening. Square chimney flues shall have a minimum net cross-sectional area of at least $^1/_{10}$ of the fireplace opening. Rectangular chimney flues with an aspect ratio less than 2 to 1 shall have a minimum net cross-sectional area of at least $^1/_{10}$ of the fireplace opening. Rectangular chimney flues with an aspect ratio of 2 to 1 or more shall have a minimum net cross-sectional area of at least $^1/_8$ of the fireplace opening.

2113.16.2 Determination of minimum area. The minimum net cross-sectional area of the flue shall be determined in accordance with Figure 2113.16. A flue size providing at least the equivalent net cross-sectional area shall be used. Cross-sectional areas of clay flue linings are as provided in Tables 2113.16(1) and 2113.16(2) or as provided by the manufacturer or as measured in the field. The height of the chimney shall be measured from the firebox floor to the top of the chimney flue.

TABLE 2113.16(1)
NET CROSS-SECTIONAL AREA OF ROUND FLUE SIZES[a]

FLUE SIZE, INSIDE DIAMETER (inches)	CROSS-SECTIONAL AREA (square inches)
6	28
7	38
8	50
10	78
10 $^3/_4$	90
12	113
15	176
18	254

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm^2.

a. Flue sizes are based on ASTM C 315.

TABLE 2113.16(2)
NET CROSS-SECTIONAL AREA OF SQUARE AND RECTANGULAR FLUE SIZES

FLUE SIZE, OUTSIDE NOMINAL DIMENSIONS (inches)	CROSS-SECTIONAL AREA (square inches)
4.5 × 8.5	23
4.5 × 13	34
8 × 8	42
8.5 × 8.5	49
8 × 12	67
8.5 × 13	76
12 × 12	102
8.5 × 18	101
13 × 13	127
12 × 16	131
13 × 18	173
16 × 16	181
16 × 20	222
18 × 18	233
20 × 20	298
20 × 24	335
24 × 24	431

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm^2.

2113.17 Inlet. Inlets to masonry chimneys shall enter from the side. Inlets shall have a thimble of fireclay, rigid refractory material or metal that will prevent the connector from pulling out of the inlet or from extending beyond the wall of the liner.

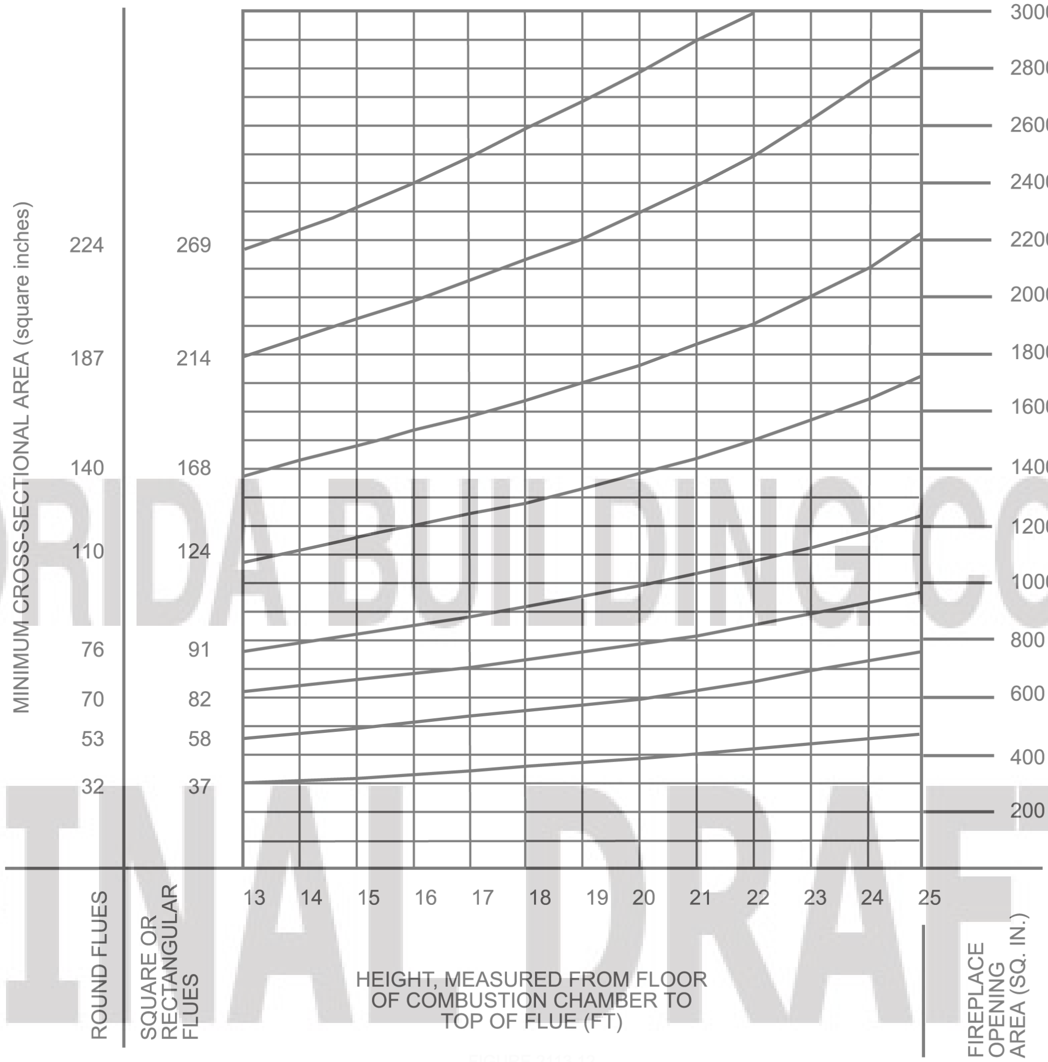
2113.18 Masonry chimney cleanout openings. Cleanout openings shall be provided within 6 inches (152 mm) of the base of each flue within every masonry chimney. The upper edge of the cleanout shall be located at least 6 inches (152 mm) below the lowest chimney inlet opening. The height of the opening shall be at least 6 inches (152 mm). The cleanout shall be provided with a noncombustible cover.

Exception: Chimney flues serving masonry fireplaces, where cleaning is possible through the fireplace opening.

2113.19 Chimney clearances. Any portion of a masonry chimney located in the interior of the building or within the exterior wall of the building shall have a minimum airspace clearance to combustibles of 2 inches (51 mm). Chimneys located entirely outside the exterior walls of the building, including chimneys that pass through the soffit or cornice, shall have a minimum airspace clearance of 1 inch (25 mm). The airspace shall not be filled, except to provide fireblocking in accordance with Section 2113.20.

Exceptions:

1. Masonry chimneys equipped with a chimney lining system listed and labeled for use in chimneys in contact with combustibles in accordance with UL 1777, and installed in accordance with the manufacturer's



For SI: 1 inch = 25.4 mm, 1 square inch = 645 mm^2.

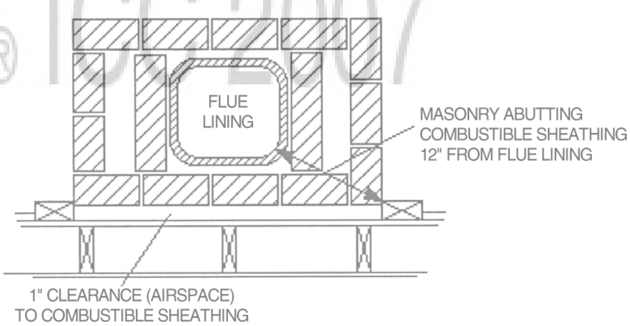
FIGURE 2113.16
FLUE SIZES FOR MASONRY CHIMNEYS

instructions, are permitted to have combustible material in contact with their exterior surfaces.

2. Where masonry chimneys are constructed as part of masonry or concrete walls, combustible materials shall not be in contact with the masonry or concrete wall less than 12 inches (305 mm) from the inside surface of the nearest flue lining.

3. Exposed combustible trim and the edges of sheathing materials, such as wood siding, are permitted to abut the masonry chimney sidewalls, in accordance with Figure 2113.19, provided such combustible trim or sheathing is a minimum of 12 inches (305 mm) from the inside surface of the nearest flue lining. Combustible material and trim shall not overlap the corners of the chimney by more than 1 inch (25 mm).

2113.20 Chimney fireblocking. All spaces between chimneys and floors and ceilings through which chimneys pass shall be



For SI: 1 inch = 25.4 mm.

FIGURE 2113.19
ILLUSTRATION OF EXCEPTION THREE CHIMNEY CLEARANCE PROVISION

fireblocked with noncombustible material securely fastened in place. The fireblocking of spaces between wood joists, beams or headers shall be to a depth of 1 inch (25 mm) and shall only be placed on strips of metal or metal lath laid across the spaces between combustible material and the chimney.

SECTION 2114 TERMITE INSPECTION

2114.1 Cleaning. Cells and cavities in masonry units and air gaps between brick, stone or masonry veneers and the structure shall be cleaned of all nonpreservative-treated or nonnaturally durable wood, or other cellulose-containing material prior to concrete placement.

Exception: Inorganic material manufactured for closing cells in foundation concrete masonry unit construction or clean earth fill placed in concrete masonry unit voids below slab level before termite treatment is performed.

2114.2 Concrete bearing ledge. Brick, stone or other veneer shall be supported by a concrete-bearing ledge at least equal to the total thickness of the brick, stone or other veneer, which is poured integrally with the concrete foundation. No supplemental concrete foundation pours which will create a hidden cold joint shall be used without supplemental treatment in the foundation unless there is an approved physical barrier. An approved physical barrier shall also be installed from below the wall sill plate or first block course horizontally to embed in a mortar joint. If masonry veneer extends below grade, a termite protective treatment must be applied to the cavity created between the veneer and the foundation, in lieu of a physical barrier.

Exception: Veneer supported by a shelf, angle or lintel secured to the foundation sidewall in accordance with ACI 530/ASCE 5/TMS 402, provided at least a 6-inch (152 mm) clear inspection space of the foundation sidewall exterior exist between the veneer and the top of any soil, sod, mulch or other organic landscaping component, deck, apron, porch, walk or any other work immediately adjacent to or adjoining the structure.

SECTION 2115 SPECIAL WIND PROVISIONS FOR MASONRY

2115.1 Gable endwalls.

2115.1.1 General. Gable endwalls shall be structurally continuous between points of lateral support.

2115.1.2 Cathedral endwalls. Gable endwalls adjacent to cathedral ceilings shall be structurally continuous from the uppermost floor to the ceiling diaphragm or to the roof diaphragm.

SECTIONS 2116 – 2117 RESERVED

SECTION 2118 HIGH-VELOCITY HURRICANE ZONES—DESIGN

2118.1 Masonry shall be designed by a method admitting of rational analysis based on established principles of mechanics.

SECTION 2119 HIGH-VELOCITY HURRICANE ZONES—QUALITY, TESTS, AND APPROVALS

2119.1 Quality. The quality of materials assembled into masonry and the method and manner of their assembly shall conform to the requirements of this chapter.

2119.1.1 Workmanship. Masonry construction shall be in conformance with the tolerances, quality and methods of construction as set forth in standards referenced in this chapter; the Portland Cement Association *Concrete Masonry Handbook,* ANSI A41.1, A41.2 and AWS Structural Welding Code: Reinforcing Steel (D1.4).

2119.1.2 Other materials. A material of masonry, other than set forth herein, which is incombustible and otherwise sufficiently embodies the characteristics and satisfies the requirements of one of the materials herein may be approved by the building official, subject to such tests as may be prescribed.

2119.2 Tests.

2119.2.1 The building official may require materials to be subjected to tests to determine their quality whenever there is reason to believe that a material is no longer up to the standards on which the approval was based. The cost of such tests shall be borne by the person or persons proposing to use or continue to use such material or product.

2119.2.2 Materials shall be tested in accordance with the standard specifications of the ASTM International as such standard specifications are noted in this chapter.

2119.3 Approvals.

2119.3.1 Only such masonry units as bear the approval of the building official and are manufactured or fabricated by plants having a certificate of competency issued by the authority having jurisdiction, shall be considered acceptable for the construction of buildings or other structures.

2119.3.2 Approval of masonry units and manufacturing or fabricating plants shall be for periods not to exceed one year and may be obtained upon application and the submission of certificates of tests in accordance with the provisions of this chapter.

2119.3.3 The provisions for tests for approval of masonry units shall not be construed as in lieu of any tests otherwise required under this chapter.

2119.3.4 Failure of a manufacturer of masonry units to obtain approval or to submit tests as required in this chapter, or such additional tests as the building official may require, shall be cause for rejection of such masonry units.

2119.4 Brick.

2119.4.1 General. Brick shall include masonry units usually $2^1/_4$ inches (57 mm) thick, $3^3/_4$ inches (95 mm) wide, and 8 inches (203 mm) long, and not less than 75 percent solid.

2119.4.2 Tests. Tests shall be conducted in accordance with *Standard Methods of Testing Brick*, ASTM C 67.

2119.4.3 Quality.

2119.4.3.1 Burned clay or shale brick shall conform to either the standard *Specification for Building Brick (Solid Masonry Units made from Clay or Shale)*, ASTM C 62, the standard *Specification for Facing Brick (Solid Masonry Units made from Clay or Shale)*, ASTM C 216 or the standard *Specification for Hollow Brick (Hollow Masonry Units made from Clay or Shale),* ASTM C 652.

2119.4.3.2 Sand-lime brick shall conform to the *Standard Specification for Concrete Building Brick,* ASTM C 55.

2119.4.3.3 Concrete brick shall conform to the *Standard Specification for Concrete Building Brick*, ASTM C 55.

2119.5 Stone. Stone for masonry shall be hard and durable.

2119.6 Cast stone. Cast stone shall be made of portland cement, aggregates and water with or without admixtures. Cast stone for load-bearing masonry or where exposed to the weather shall have an average compressive strength, at 28 days, of at least 3,000 pounds psi (20.7 MPa) and shall have not more than 7 percent water absorption by weight.

2119.7 Concrete blocks.

2119.7.1 General.

2119.7.1.1 Concrete blocks shall be made of portland cement, water and approved aggregates. The materials shall conform to the requirements for the materials of concrete specified in Chapter 19 (High-Velocity Hurricane Zones), and the finished units shall meet the requirements of this section.

2119.7.1.2 Concrete blocks used for fire-resistive walls rated 2 hours or more, or used for load-bearing or exterior walls, shall have a minimum face shell thickness of $1^1/_4$ inches (32 mm), a minimum web thickness of 1 inch (25.4 mm), and shall have a net cross-sectional area not less than 50 percent of the gross section.

2119.7.1.3 Concrete blocks for other purposes shall have wall and web thickness of not less than $^3/_4$ inch (19 mm).

2119.7.1.4 Where masonry walls are required by this code to be 8 inch (203 mm) thickness, hollow concrete blocks units may be $7^5/_8$ by $7^5/_8$ by $15^5/_8$ inches (195 by 195 by 398 mm) modular dimension with corresponding widths for tie columns and tie beams.

2119.7.2 Quality. Standard units of hollow concrete block shall conform to the *Standard Specification for Hollow Load-Bearing Concrete Masonry Units,* ASTM C 90, except that the maximum moisture content shall not exceed 50 percent of the total absorption.

2119.8 Structural clay tile.

2119.8.1 Limitations. All hollow burned clay wall tile used for fire-resistive walls rated 2 hours or more, load-bearing or exterior walls shall be load bearing tile.

2119.8.2 Tests. Tests shall be conducted in accordance with the *Standard Methods of Sampling and Testing Structural Clay Tile,* ASTM C 212.

2119.8.3 Quality.

2119.8.3.1 Structural clay load-bearing wall tile shall conform to the *Standard Specification of Structural Clay Load-Bearing Wall Tile*, ASTM C 34.

2119.8.3.2 Structural clay floor tile shall conform to the *Standard Specification for Structural Clay Floor Tile,* ASTM C 57.

2119.8.3.3 Structural clay nonload-bearing tile shall conform to the *Standard Specification for Structural Clay NonLoad-Bearing Tile,* ASTM C 56.

2119.9 Gypsum tile.

2119.9.1 Limitations. Precast gypsum shall not be used in load-bearing masonry or in any masonry that will be exposed to the weather.

2119.9.2 Tests. Tests shall be made in accordance with the *Chemical Analysis of Testing Gypsum and Gypsum Products,* ASTM C 471, *Physical Testing of Gypsum Plasters and Gypsum Cement*, ASTM C 472, and *Physical Testing of Gypsum Board Products and Gypsum Partition Tile and Block,* ASTM C 473.

2119.9.3 Quality. Gypsum partition tile or block shall conform to the *Standard Specification for Gypsum Tile or Block*, ASTM C 52, *Chemical Analysis of Testing Gypsum and Gypsum Products,* ASTM C 471, *Physical Testing of Gypsum Plasters and Gypsum Cement,* ASTM C 472, and *Physical Testing of Gypsum Board Products and Partition Tile and Block,* ASTM C 473.

2119.10 Plain concrete. Plain concrete is concrete cast in place and not reinforced, or reinforced only for shrinkage or change of temperature. Plain concrete shall be mixed, placed and cured as specified for concrete in Chapter 19 (High-Velocity Hurricane Zones). The minimum strength of regular concrete shall be not less than 2000 psi (13.8 MPa) in 28 days. The minimum strength of lightweight aggregate concrete shall be not less than 500 psi (3.5 MPa) in 28 days.

2119.11 Plain gypsum concrete. Plain gypsum concrete is gypsum concrete cast in place and either unreinforced or reinforced for shrinkage.

2119.12 Mortar.

2119.12.1 General. Except as otherwise set forth herein, all mortars and the materials therein shall conform to the *Standard Specifications for Mortar of Masonry Units*, ASTM C 270.

2119.12.1.1 The gradation of aggregates for masonry mortar shall be such that the fineness modulus is between 1.20 and 2.35 when determined in accordance with the *Standard Specifications for Aggregate for Masonry Mortar,* ASTM C 144.

2119.12.1.2 Aggregates shall be quarried or washed in fresh water and shall contain not more than $^{1}/_{20}$ of 1 percent salt by weight.

MORTAR STRENGTH PROPERTY SPECIFICATIONS

Type	Minimum Average Strength (psi) (MPa)
M	2500 (17.2)
S	1800 (12.4)
N	750 (5.2)
O	350 (2.4)

2119.12.1.3 Mortar used to bond unit masonry shall be of Type M, S, N or O and shall comply with either the property specifications set forth hereinafter or the proportion specifications of the standard set forth in Section 2119.12.1.

2119.12.1.4 The type of mortar based on consideration of the location of the unit masonry shall be as follows:

USE OF LOCATION	TYPE OF MORTAR
Below grade foundations and walls	M
Swimming pool walls and retaining walls	M
Fire resistive walls rated 2 hours or more	M or S
Exterior walls and load bearing walls	M or S
Piers less than 32 inches wide	M or S
Partitions	M, S or N
Solid masonry units	One classification less than that above
Mortar or grout under concentrated loads	M
Fences	M, S, N or O
Gypsum	Gypsum

For SI: 1 inch = 25.4 mm.

2119.12.1.5 All solid unit masonry shall be laid in full beds with full end joints. All hollow unit masonry shall be laid with full mortar coverage of the face shells in both horizontal and vertical joints.

SECTION 2120 HIGH-VELOCITY HURRICANE ZONES— ALLOWABLE UNIT STRESSES IN UNIT MASONRY

2120.1 Compression.

2120.1.1 Allowable working compressive stresses in masonry walls shall not exceed the limits in pounds per square inch (MPa) of gross area in the following table:

Unit	Type N or O Mortar	Type M or S Mortar
Brick	200 (1.4)	300 (2.1)
Stone	450 (3.1)	600 (4.1)
Rubble Stone	200 (1.4)	300 (2.1)
Concrete Blocks	100 (0.7)	150 (1.0)
Clay Tile	80 (0.55)	100 (0.7)

2120.1.2 The maximum allowable working stress in plain concrete shall be the following percentage of the ultimate strength of the concrete in compression:

Compression $0.20\,f'_c$

Shear and diagonal tension $0.02\,f'_c$

Where f'_c represents the ultimate compressive strength.

2120.2 The shear in unit masonry shall not exceed $^{1}/_{10}$ the allowable compressive stress.

2120.3 Unreinforced unit masonry shall be assumed to have no value in resisting axial tension. Flexural tension is allowed in unreinforced masonry per ACI 530.

2120.4 Concentrations. Walls of hollow masonry units shall not directly support concentrated loads.

SECTION 2121 HIGH-VELOCITY HURRICANE ZONES— CONSTRUCTION DETAILS

2121.1 General.

2121.1.1 Masonry walls of hollow or solid units or plain concrete shall be constructed as specified in this section.

2121.1.2 Designed reinforced concrete walls, columns and beams shall be as specified in Chapter 19 (High-Velocity Hurricane Zones), except that such designed columns and beams shall be not less than the equivalent of the minimums herein set forth.

2121.1.3 Reinforced concrete required in this section shall comply with Chapter 19 (High-Velocity Hurricane Zones), Reinforced Concrete.

2121.1.4 Second-hand masonry units shall not be used unless they conform to the requirements of this code, are sound and have been thoroughly cleaned and are approved for use by the building official.

2121.1.5 Bond shall be provided by lapping ends in successive vertical courses.

2121.1.6 Minimum No. 9 gauge horizontal joint reinforcing at every alternate course (16-inch (406 mm) spacing), ladder type for reinforced masonry and truss type for all others shall be provided. This reinforcement shall extend 4 inches (102 mm) into tie columns or be tied to structural columns with approved methods where structural columns replace the tie columns.

2121.2 Exterior walls.

2121.2.1 General.

2121.2.1.1 Exterior walls of unit masonry shall have a minimum thickness of 8 inches (203 mm) except as otherwise set forth in Section 2121.2.11 and 2119.7.1.4.

2121.2.1.2 No roof or other members shall be placed to develop direct horizontal thrust on walls unless such walls are specifically designed.

2121.2.1.3 The maximum area of wall panels of 8 inch (203 mm) thick unit masonry, as measured between the concrete members which frame the panel such as the beams and tie columns, shall not exceed 240 square feet (22.3 m^2), except as set forth in Section 2121.2.2.

2121.2.2 Tie columns.

2121.2.2.1 Concrete tie columns shall be required in exterior walls of unit masonry. Concrete tie columns shall be required at all corners, at intervals not to exceed 16 feet (4.9 m) center-to-center of columns, adjacent to any corner opening exceeding 4 feet (1219 mm) in width, and at the ends of free-standing walls exceeding 2 feet (610 mm) in length. When openings exceed 8 feet (2.4 m) in width, tie columns shall be provided on each side of all such openings. All gable and shed end corners shall have tie columns.

2121.2.2.2 When openings are between 3 and 8 feet (914 mm and 2.4 m) in width, such openings shall have one #5 vertical reinforcing bar at each side. The vertical bars shall be placed in concrete filled cells and shall extend into footings and into tie beams. All such bars shall be continuous from footing to tie beam. All splices, where needed, shall be 30 inches (762 mm) minimum.

2121.2.2.3 Tie columns shall be not less than 12 inches (305 mm) in width. Tie columns having an unbraced height not exceeding 15 feet (4.6 m) shall be not less in thickness than the wall or less than a nominal 8 inches (203 mm), and, where exceeding 15 feet (4.6 m) in unbraced height, shall be not less in thickness than 12 inches (305 mm). The unbraced height shall be taken at the point of positive lateral support in the direction of consideration or the column may be designed to resist applicable lateral loads based on rational analysis.

2121.2.2.4 Tie columns shall be reinforced with not less than four #5 vertical bars for 8 inch by 12 inch (203 mm by 305 mm) columns nor less than four #6 vertical bars for 12 inch by 12 inch (305 mm by 305 mm) columns nor less reinforcing steel than 0.01 of the cross-sectional area for columns of other dimension nor less than may be required to resist axial loads or bending forces. Vertical reinforcing shall be doweled to the footing and splices shall be lapped 30 bar diameters. Columns shall be tied with #2 hoops spaced not more than 12 inches (305 mm) apart.

2121.2.2.5 The concrete tie columns set forth herein are a minimum to limit masonry panel areas and provide an integrated framework for masonry. The spacing of concrete columns for skeleton frame construction, designed as specified in Chapter 19 (High-Velocity Hurricane Zones), may exceed the spacing herein set forth provided the masonry panels have an area less than 240 square feet (22.3 m^2) and the structural system is designed to transmit horizontal wind loads to the columns.

2121.2.2.6 Concrete tie columns designed to limit masonry panel areas may be offset at tie beams or other horizontal members to avoid openings, but the maximum spacing shall not be exceeded.

2121.2.2.7 Concrete columns in load-bearing walls shall be poured only after masonry units are in place. Where masonry walls of skeleton frame construction are laid up after the frame has been erected, adequate anchorage designed by a professional engineer shall be provided. Where structural steel members are made fire-resistive with masonry units, the panel walls shall be bonded to the fire-resistive materials.

2121.2.2.8 Where the minimum spacing of tie columns, as set forth in Section 2121.2.2.1, has been satisfied and structural columns of skeleton frame construction are spaced as specified in Section 2121.2.2.5, provision for resisting the horizontal and vertical loads at the edges of masonry panels abutting door and window openings in masonry walls where openings are not bounded by such reinforced concrete columns shall be considered and, where necessary, transfer the forces through the materials of assembly to the ground.

2121.2.3 Tie beams.

2121.2.3.1 A tie beam of reinforced concrete shall be placed in all walls of unit masonry, at each floor or roof level, and at such intermediate levels as may be required to limit the vertical heights of the masonry units to 16 feet (4.9 m). Well-compacted and confined soil below grade may be considered lateral restraint but only above a point 1 foot (305 mm) below the grade where such restraint begins.

2121.2.3.2 Unless otherwise required by design, all tie beams shall have four #3 ties at 12 inches (305 mm) o.c. at corners and at each bend and at 48 inches (1219 mm) o.c. elsewhere. A tie beam shall be not less in dimension or reinforcing than required for the conditions of loading nor less than the following minimums: a tie beam shall have a width of not less than a nominal 8 inches (203 mm), shall have a height of not less than 12 inches (305 mm) and shall be reinforced with not less than four #5 reinforcing bars placed two at the top and two at the bottom of the beam except that a tie beam using "U" type beam block may be used with the following limitations:

1. Limited to one-story Group R3 occupancy.
2. Limited to unsupported spans of 7 feet (2.1 m).
3. Beam block shall be reinforced with one #7 bar in the top and one #7 bar in the bottom of the pour.
4. Beam block shall provide not less than 14 inches (356 mm) vertical dimension or less than $4^1/_2$ inches (114 mm) horizontal dimension of poured-in-place beam cross-section.
5. Where beam blocks are used, consideration of resistance to uplift caused by wind forces shall be based on only that portion of the dead load above the topmost mortar joint in the wall.

2121.2.3.3 The tie beam shall be continuous. Continuity of the reinforcing in straight runs shall be provided by lapping splices not less than 30 inches (762 mm). Continuity shall be provided at corners by bending two bars from each direction around the corner 30 inches (762 mm) or by adding two #5 bent bars which extend 30 inches (762 mm) each way from the corner. Continuity at columns shall be provided by continuing horizontal reinforcing through columns or by bending horizontal reinforcing in the columns a distance of 18 inches (457 mm).

2121.2.3.4 A tie beam shall not be required where floor or roof systems provide a rigid diaphragm of reinforced concrete with a minimum thickness of 4 inches (102 mm) or where a floor or roof system has an equivalent stiffness factor of not less than 0.5 cubic inches, as determined by the moment of inertia divided by the length. (Per foot of width, measured normal to the plane of the diaphragm and adequately anchored).

2121.2.3.5 Changes in level of the beams or structural concrete beams (beam) shall be made at tie columns or structural concrete columns and said tie columns or structural concrete columns shall be continuous from beam to beam.

2121.2.3.6 A tie beam may follow the rake of a gable or shed end if the slope does not exceed 3:12 and the requirements of Sections 2121.2.1.2 and 2121.2.1.3 are met.

2121.2.3.7 The concrete in tie beams shall be placed to bond to the masonry units immediately below and shall not be separated therefrom by wood, felt or any other material which may prevent bond. Felt paper no wider than the width of the cells of the block may be used provided that it is depressed a minimum of 2 inches (51 mm) in one cell of each block.

2121.2.3.8 Tie beams subject to uplift and lateral wind forces shall be sized and designed to resist all such forces. Tie beams over openings shall be sized and designed to resist dead and live loads combined with wind loads, whichever governs.

2121.2.4 Gable end and shed end walls. All masonry structures with gable end and shed end (half gable) walls shall have such end walls constructed of masonry, only in accordance with this section. A horizontal tie beam shall be provided in line with the lower ends of the gables and sheds, except as permitted in Section 2121.2.3.6 above, and designed in accordance with Sections 2121.2.1.2 and 2121.2.1.3, and load requirements as set forth in Chapter 16 (High-Velocity Hurricane Zones). A concrete coping following the rake of the gable, not less than 64 square inches (.04 m^2) in area reinforced with two #5 bars shall be provided. Tie columns at gable and shed ends shall be provided. Any intermediate tie columns required within the gable shall extend to the coping beam. Tie beams resting on masonry which are not subject to uplift and lateral wind forces shall be provided according to Section 2121.2.3.2.

2121.2.5 Parapet walls.

2121.2.5.1 Masonry parapet walls shall be not less than 8 inches (203 mm) thick, shall be reinforced with minimum tie columns and shall be coped with a concrete beam not less than 64 square inches (.04 m^2) in cross-section, reinforced with two #4 reinforcing bars.

2121.2.5.2 A parapet wall exceeding 5 feet (1524 mm) in height above a tie beam or other point of lateral support shall be specifically designed to resist horizontal wind loads.

2121.2.6 Piers.

2121.2.6.1 In any section of a masonry wall of an enclosed structure where openings are arranged to leave sections of walls less than 16 inches (406 mm), such sections shall be steel or reinforced concrete.

2121.2.6.2 Isolated masonry piers of unenclosed structures shall be so constructed that the height of such piers shall not exceed 10 times the least dimension, that the cells are filled with cement grout and reinforced with not less than two #5 bars anchoring the beam to the foundation.

2121.2.7 Cavity walls.

2121.2.7.1 Cavity walls consisting of two separate walls with an air space of not less than 2 inches nor more than 6 inches (51 to 152 mm) may be constructed of solid or hollow-unit masonry provided such walls meet the specific requirements for tie columns and beams set forth in this section and are bonded together at intervals not more than 24 inches (610 mm) apart, vertically and horizontally, by masonry ties or by durable, rigid metal ties 0.10 square inch (64.5 mm^2) in the cross section.

2121.2.7.2 The minimum thickness of the separate walls of cavity wall construction shall be 4 inches (102 mm), and units shall be laid in full beds of portland cement mortar with full-end joints.

2121.2.8 Brick and stone walls. Walls of brick and stone shall be laterally supported by tie columns and beams, or the equivalent thereof, as provided in this section and shall meet these additional requirements:

1. In all brick walls at least every sixth course on both sides of the wall shall be a header course or there shall be at least one full header in every 72 square inches (.05 m^2) of each wall surface.
2. In walls more than 12 inches (305 mm) thick, the inner joints of header courses shall be covered with another header course that shall break joints with the course below.
3. Solid-unit masonry shall comply with the standard *Building Code Requirements for Masonry,* ANSI A41.1.
4. Rubble stone walls shall be 4 inches (102 mm) thicker than is required for solid brick or concrete walls of the same respective heights, but in no part less than 16 inches (406 mm).

2121.2.9 Substitutions.

2121.2.9.1 Where, for architectural reasons or otherwise, it is desirable to reduce the area of any required tie column or tie beam below the specified requirements, the building official may grant such reduction, provided that the area of concrete omitted shall be replaced by reinforcing or structural steel in the ratio 1:(n-1) where "n" is defined as the modular ratio of elasticity (esteel/econcrete).

2121.2.9.2 Where it is desired to substitute for the #5 reinforcing as required by this section, three #4 bars may be substituted to replace two #5 bars.

2121.2.10 Wall additions. Where new walls are connected to existing walls, such connection shall be by means of a starter column of minimum 8 inches by 8 inches (203 mm by 203 mm) dimension reinforced with two #5 bars.

2121.2.11 Chases, recesses and openings.

2121.2.11.1 Unit masonry walls required to be a minimum of 8 inches (203 mm) thick, such as exterior walls, fire walls and bearing walls, may be chased or recessed not deeper than one-half the wall thickness for an area not exceeding 8 square feet (0.74 m^2), provided the horizontal dimension of the chase or recess does not exceed 4 feet (1219 mm) and provided the chasing shall not reduce the dimension of tie beams and tie columns to less than herein required, except as follows:

Exception: Four-inch (102 mm) deep chases or recesses in 8 inch (703 mm) unit masonry walls may be constructed with 4 inch (102 mm) unit masonry panels provided such 4 inch (102 mm) unit masonry panel does not exceed 5 feet (1524 mm) in width, does not exceed 8 feet (2.4 m) in height, is bonded on one vertical side to 8 inch (203 mm) masonry or a tie column, and is not load bearing. Where such panel exceeds 2 feet (610 mm) in width at locations 20 feet (6.1 m) or more above grade in exterior walls, resistance to wind load shall be considered in the design, and a minimum of 4 inch by 8 inch (102 mm by 203 mm) tie column with two #5 vertical bars shall be provided in the free standing end of such 4 inch (102 mm) wall.

2121.2.11.2 Openings shall have lintels of reinforced concrete. Where such lintel is precast or formed separately from a tie beam, it shall bear not less than nominal 8 inches (203 mm) on the masonry, at each end except as may otherwise be approved for compliance with this code by product approval, or after rational analysis, but not less than 4 inches (102 mm). Where such lintel is formed integrally with the tie beam by deepening the tie beam above the opening, and the tie beam itself is capable of safely supporting all loads, the beam may span up to 6 feet (1.8 m) in length and may be deepened not to exceed 8 inches (203 mm) without additional reinforcing. Where the tie beam is deepened in excess of 8 inches (203 mm) with a span less than 6 feet (1.8 m) in length, and the tie beam itself is capable of supporting all loads, the dropped portion shall contain a #3 horizontal bar at the bottom, bent up at each end and fastened to the upper tie beam steel or two #4 horizontal bars. The dropped portion shall bear at least 4 inches (102 mm) on the masonry at each end. Where the span is in excess of 6 feet (1.8 m), the principal beam reinforcing shall be at the bottom of the beam.

2121.2.12 Glass unit masonry. Glass unit masonry shall comply with section 2121.1.12 or shall comply with ACI 530/ASCE 5/TMS 402 and section 2121.2.12.2.

2121.2.12.1 Masonry of glass unit masonry may be used in nonload-bearing exterior or interior walls and in openings which might otherwise be filled with windows, either isolated or in continuous bands, provided the glass unit masonry panels have a thickness of not less than 3½ inches (89 mm) at the mortar joint and the mortared surfaces of the units are satisfactorily treated for mortar bonding.

2121.2.12.2 Glass unit masonry panels for exterior walls shall have a Product Approval.

2121.2.12.3 Exterior unit masonry panels shall be set in recesses at the jambs and, for panels exceeding 10 feet (3 m) in horizontal dimension between supports, at the head as well, to provide a bearing surface at least 1 inch (25 mm) wide along the panel edges; except that when approved by the building official for panels exceeding neither 100 square feet (9.3.m^2) in area nor 10 feet (3 m) in either horizontal or vertical dimension, and situated four stories or less, and less than 52 feet (15.8 m) above grade level, anchorage may be provided by means of non-corrodible perforated metal strips.

2121.2.12.4 Glass unit masonry panels shall have reinforcement in the mortar joints spaced not more than 2 feet (610 mm) apart vertically and below and above any openings within a pane. The reinforcement shall consist of two parallel longitudinal galvanized steel wires, No. 9 gauge or larger, spaced 2 inches (51 mm) apart, and welded to No. 14 or heavier cross wires at intervals not exceeding 8 inches (203 mm), or the equivalent approved by the building official.

2121.2.12.5 Glass unit masonry shall be laid in only Type M or S mortar or equivalent approved material. Both vertical and horizontal mortar joints shall be at least $^1/_4$ inch (6 mm) and not more than $^3/_8$ inch (9.5 mm) thick and shall be completely filled.

2121.2.12.6 Every exterior glass unit masonry panel shall be provided with expansion joints at the sides and top. Expansion joints shall be entirely free of mortar, and shall be filled with resilient material.

2121.2.12.7 Glass masonry units required to provide a fire resistance rating shall comply with Section 2121.1.12.8 or shall be fire tested and listed for their intended use.

2121.2.12.8 View panels in 1-hour fire-resistant walls shall be limited to glass unit masonry panels installed in steel channels, or panel anchor framing may be used where a $^3/_4$-hour fire rating is required. Three-and-seven-eighths inch thick (98 mm) glass masonry unit shall be limited to 120 square feet (1.1 m^2) with no dimension greater than 12 feet (3.7 m) for masonry wall construction or to 94 square feet (8.7 m^2) with no dimension greater than 10.75 feet (3.3 m) for nonmasonry wall construction. Three and one-eighths inch (79 mm) thick glass masonry units shall be limited to 100 square feet (9.3 m^2) with no dimension greater than 10 feet (3 m) for masonry wall construction or to 94 square feet (8.7 m^2) with no dimension greater than 10.75

feet (3.3 m) for nonmasonry wall construction. Three inches (76 mm) thick glass masonry units shall be limited to 100 square feet (9.3 m^2) with no dimension greater than 12 feet (3.7 m) for masonry wall construction or to 94 square feet (8.7 m^2) with no dimension greater than 10 feet (3 m) for nonmasonry wall construction.

View panels in 2-hour fire-resistant walls shall be limited to glass masonry units installed in steel channels and with a water curtain in conformance with NFPA 13 on each side at interior walls or at the interior of exterior walls. Three and seven-eighths inch (98 mm) thick glass masonry units shall be limited to 100 square feet (9.3 m^2) with no dimension greater than 10 feet (3 m).

The view panel assembly shall not exceed 25 percent of the wall separating a tenancy from a corridor or a corridor from an enclosed vertical opening or one fire-rated area from another fire-rated area.

Maximum $^3/_4$ hour fire-rated glass masonry units construction shall be used at nonmasonry wall construction. Panel anchors shall be provided at sill and jambs in nonmasonry wall construction using panel anchor framing. A fire-retardant sealant shall be used at all channel and panel anchor framing. Expansion material at heads and jambs shall be either fibrous glass or mineral wool. All fire-rated glass masonry units and panels shall conform to UL No. 9 and ASTM E 163.

2121.2.12.9 Interior glass masonry unit panels having thickness of $3^7/_8$ inches (98 mm) shall not exceed 250 square feet (23.2 m^2) of unsupported wall surface and interior glass masonry unit panels having thickness of $3^1/_8$ inches (79 mm) shall not exceed 150 square feet (13.9 m^2) of unsupported wall surface nor more than 25 feet (7.6 m) in length nor more than 20 feet (6.1 m) in height between supports.

2121.2.13 Grill block.

2121.2.13.1 Decorative grills or screens constructed of unit masonry laid with cells open through the wall shall be as set forth herein or designs shall be based on rational analysis to resist applicable loads and computations shall be submitted to the building official for approval.

2121.2.13.2 Unit masonry grills or screens as described in this paragraph shall not be load bearing.

2121.2.13.3 Unit masonry in exterior wall shall be laid in Type M or S mortar.

2121.3 Interior bearing walls. Interior-bearing walls shall be constructed as specified in Section 2121.2 for exterior walls, except that interior bearing walls in one-story building of Group H or I occupancy, where not required to be more than 1-hour fire-resistive, may be constructed of 4 inch (162 mm) concrete block not exceeding 9 feet (2.7 m) in height, capped with a reinforced concrete beam not less than 4 inches (102 mm) in width nor less than 12 inches (305 mm) in height, reinforced with two $^1/_2$-inch (12.7 mm) rods, and such walls shall support only a roof or ceiling not in excess of 700 pounds per lineal foot (10.2 kN/m) with no chases or recesses.

2121.4 Fire walls. Firewalls shall be constructed as set forth in Section 2121.2 for exterior walls.

2121.5 Panel walls.

2121.5.1 Panel walls of unit-masonry shall be not less than 8 inches (203 mm) thick and shall be limited in panel dimension as set forth in Section 2121.2.

2121.5.2 Panel walls of reinforced concrete shall be not less than 4 inches (102 mm) thick nor less than required by design as specified in Chapter 19 (High-Velocity Hurricane Zones).

2121.6 Veneered walls.

2121.6.1 Masonry backing.

2121.6.1.1 Veneering or facing on masonry backing shall not be considered as adding any strength to such walls and shall be limited in height above foundations or between proper and adequate supports to 30 feet (9.1 m). Veneering shall be securely anchored to masonry backing by means of substantial, noncorroding metal wall ties, spaced not farther apart than 16 inches (406 mm) vertically or 24 inches (610 mm) horizontally.

2121.6.1.2 Tile veneering, not more than 1 inch (25 mm) thick with individual units not exceeding 20 inches (508 mm) in any dimension and having not more than 200 square inches (.13 cm^2) of surface area with corrugations or scoring on the back side thereof, need not be anchored in accordance with the above requirements but shall be cemented solid to the backing with portland cement mortar so as to provide a continuous integral support to the backing.

2121.6.2 Wood backing.

2121.6.2.1 In all cases, before applying masonry veneer, a substantial waterproofed paper or asphalt-saturated felt, weighing not less than 14 pounds per 100 square feet (0.68 kg/m^2) shall be applied horizontally, shingle fashion, over diagonal sheathing. Horizontal joints in the paper or felt shall be lapped not less than 4 inches (102 mm) and vertical end joints not less than 6 inches (152 mm).

2121.6.2.2 Masonry veneer shall be not less than $3^3/_4$ inches (95 mm) thick and shall be bonded to the backing by means of substantial noncorroding metal wall ties spaced not farther apart than 16 inches (406 mm) vertically and 24 inches (610 mm) horizontally.

2121.7 Partitions.

2121.7.1 The requirements specified herein shall apply to nonbearing interior separations, other than firewalls, of unit masonry construction.

2121.7.2 The lateral distance between vertical supports of nonbearing interior partitions of unit masonry shall not exceed 72 times the actual thickness of the partition, including plaster.

2121.7.3 The height of unit masonry partitions shall not exceed 36 times the actual thickness, including plaster.

2121.7.4 All interior unit masonry partitions shall be designed to meet the lateral live load requirements with corresponding perimeter anchorage supports, in accordance with Section 1618.8.

2121.8 Fences.

2121.8.1 Masonry fences so located on a property that such fence, at the proposed height or by a future addition to height, could be used as a wall of a building shall be constructed with foundations and tie columns as provided for an exterior wall. Such fence shall be capped with a coping beam not less than 64 square inches (.4 m^2) in cross-section reinforced with a minimum of two #4 rods, when not exceeding a height of 5 feet (1.5 m), or shall be capped by a tie beam as provided for exterior walls if exceeding a height of 5 feet (1.5 m).

2121.8.2 Masonry fences, so located on a property that by zoning regulation such fence could not be used as a wall of a building, shall be constructed as follows:

2121.8.2.1 Fences not exceeding 5 feet (1.5 m) in height shall be 8 inches (203 mm) thick and shall not be required to have tie columns, but shall be required to have a coping as provided herein; or such fences may be 4 inches (102 mm) thick with tie columns and coping not less than 8 inches (203 mm) thick.

2121.8.2.2 Fences exceeding 5 feet (1.5 m) in height shall be not less than 8 inches (203 mm) thick and shall have tie columns and tie beams as required for exterior walls.

2121.9 Other masonry walls. Walls of masonry materials or arrangements of masonry units other than those specifically set forth in this chapter shall be in conformance with the general provisions of this code, may be classified by the subject to all or any of the requirements therefor to and any such additional requirements as the building official may prescribe.

SECTION 2122 HIGH-VELOCITY HURRICANE ZONES— REINFORCED UNIT MASONRY

2122.1 Standards. The provisions of ACI 530/ASCE 5, *Building Code Requirements For Masonry Structures*, and the commentary on *Building Code Requirements for Masonry Structures*, are hereby adopted as a minimum; however, the requirement of the standard shall not supersede the specific requirements of this chapter.

2122.2 General.

2122.2.1 Tie columns and tie beams as set forth in Section 2121.2 shall be not required where design and construction are in accordance with the provisions of this section.

2122.2.2 Reinforced unit masonry shall be steel reinforced solid-unit masonry or steel reinforced grouted hollow-unit masonry as set forth herein.

2122.3 The design of buildings and structures of reinforced unit masonry shall be by a professional engineer or registered architect.

2122.4 Special inspector. A Florida-registered architect or professional engineer shall furnish inspection of all reinforced masonry structures.

2122.5 Concrete masonry strength.

2122.5.1 In each test of three prisms, the average of the three may be used as the assumed value of f'_m.

2122.5.2 In no case shall the value of f'_m exceed the lowest break multiplied by 1.25 in any test.

2122.6 Reinforced masonry columns and walls.

2122.6.1 The minimum length of lap for deformed bars in grout, in tension or compression, shall be 48 bar diameters, but not less than 12 inches (305 mm).

2122.6.2 Concentrated loads shall not be assumed distributed across continuous vertical joints, including stack bond joints, unless reinforcing elements are designed and provided to distribute such loads.

2122.6.3 Reinforced masonry bearing walls shall have a nominal thickness of at least $^1/_{30}$ of the unsupported height or width, whichever is the shorter, but not less than 8 inches (203 mm).

2122.6.4 Anchorage requirements.

2122.6.4.1 Reinforced masonry walls shall be securely anchored to adjacent structural members such as roofs, floors, columns, pilasters, buttresses and intersection walls.

2122.6.4.2 Masonry walls shall be anchored to all floors and roofs that provide lateral support to such walls.

2122.6.4.3 Such anchorage shall provide a positive direct connection capable of resisting the horizontal forces as required in Chapter 16 (High-Velocity Hurricane Zones), or a minimum force of 200 pounds per lineal foot (2919 N/m) of wall, whichever is greater.

2122.6.4.4 Required anchors shall be embedded in reinforced grouted cells.

2122.6.4.5 Wood framing connected by nails shall not be considered as acceptable anchorage.

2122.6.5 Mortar and grout.

2122.6.5.1 Vertical cells to be grouted shall provided vertical alignment sufficient to maintain clear, unobstructed, continuous, vertical cores measuring not less than 2 inches by 3 inches (51 mm by 76 mm).

2122.6.5.2 Vertical grout barriers or dams of solid masonry spaced not more than 25 feet (7.6 mm) apart shall be provided across the grout space in the entire height of the wall to control the flow of grout horizontally.

2122.6.5.3 Grout shall be a plastic mix having a maximum slump of 9 inches +/-1 inch (229 +/-25 mm).

2122.6.5.4 Grout shall be placed before any initial set has occurred, but in no case more than $1^1/_2$ hours after the mix-designed water has been added.

2122.6.5.5 Grouting shall be a continuous operation in lifts not exceeding 4 feet (1.2 m) and a maximum pour of 12 feet (23.7 m).

2122.6.5.6 Grouting shall be consolidated between lifts by puddling, rodding or mechanical vibration.

2122.6.5.7 The grouting of any section of wall between control barriers shall be completed in one operation with no interruptions exceeding 1 hour.

2122.6.6 Bearing. Precast floor and roof units supported on masonry walls shall provide minimum bearing of 3 inches (76 mm) and anchorage in accordance with Section 2122.6.4.

2122.6.7 Protection of masonry. Unfinished work shall be stopped back for joining with new work; toothing being permitted only with the approval of the special inspector.

CHAPTER 22

STEEL

SECTION 2201 GENERAL

2201.1 Scope. The provisions of this chapter govern the quality, design, fabrication and erection of steel used structurally in buildings or structures.

> **Exception:** Buildings and structures located within the high-velocity hurricane zone shall comply with the provision of Sections 2214 through 2224.

SECTION 2202 DEFINITIONS

2202.1 Definitions. The following words and terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meaning shown herein.

STEEL CONSTRUCTION, COLD-FORMED. That type of construction made up entirely or in part of steel structural members cold formed to shape from sheet or strip steel such as roof deck, floor and wall panels, studs, floor joists, roof joists and other structural elements.

STEEL JOIST. Any steel structural member of a building or structure made of hot-rolled or cold-formed solid or open-web sections, or riveted or welded bars, strip or sheet steel members, or slotted and expanded, or otherwise deformed rolled sections.

STEEL MEMBER, STRUCTURAL. Any steel structural member of a building or structure consisting of a rolled steel structural shape other than cold-formed steel, or steel joist members.

SECTION 2203 IDENTIFICATION AND PROTECTION OF STEEL FOR STRUCTURAL PURPOSES

2203.1 Identification. Steel furnished for structural load-carrying purposes shall be properly identified for conformity to the ordered grade in accordance with the specified ASTM standard or other specification and the provisions of this chapter. Steel that is not readily identifiable as to grade from marking and test records shall be tested to determine conformity to such standards.

2203.2 Protection. Painting of structural steel shall comply with the requirements contained in AISC 360. Individual structural members and assembled panels of cold-formed steel construction, except where fabricated of approved corrosion-resistant steel or of steel having a corrosion-resistant or other approved coating, shall be protected against corrosion with an approved coat of paint, enamel or other approved protection.

SECTION 2204 CONNECTIONS

2204.1 Welding. The details of design, workmanship and technique for welding, inspection of welding and qualification of welding operators shall conform to the requirements of the specifications listed in Sections 2205, 2206, 2207, 2209 and 2210.

2204.2 Bolting. The design, installation and inspection of bolts shall be in accordance with the requirements of the specifications listed in Sections 2205, 2206, 2209 and 2210.

2204.2.1 Anchor rods. Anchor rods shall be set accurately to the pattern and dimensions called for on the plans. The protrusion of the threaded ends through the connected material shall be sufficient to fully engage the threads of the nuts, but shall not be greater than the length of the threads on the bolts.

SECTION 2205 STRUCTURAL STEEL

2205.1 General. The design, fabrication and erection of structural steel for buildings and structures shall be in accordance with AISC 360.

2205.2 Seismic requirements for steel structures. Reserved.

2205.3 Seismic requirements for composite construction. Reserved.

SECTION 2206 STEEL JOISTS

2206.1 General. The design, manufacture and use of open web steel joists and joist girders shall be in accordance with one of the following Steel Joist Institute (SJI) specifications:

1. SJI K-1.1
2. SJI LH/DLH-1.1
3. SJI JG-1.1

2206.2 Design. The registered design professional shall indicate on the construction documents the steel joist and/or steel joist girder designations from the specifications listed in Section 2206.1 and shall indicate the requirements for joist and joist girder design, layout, end supports, anchorage, non-SJI standard bridging, bridging termination connections and bearing connection design to resist uplift and lateral loads. These documents shall indicate special requirements as follows:

1. Special loads including:
   - 1.1. Concentrated loads;
   - 1.2. Nonuniform loads;
   - 1.3. Net uplift loads;
   - 1.4. Axial loads;

1.5. End moments; and

1.6. Connection forces.

2. Special considerations including:

   2.1. Profiles for nonstandard joist and joist girder configurations (standard joist and joist girder configurations are as indicated in the SJI catalog);

   2.2. Oversized or other nonstandard web openings; and

   2.3. Extended ends.

3. Deflection criteria for live and total loads for non-SJI standard joists.

2206.3 Calculations. The steel joist and joist girder manufacturer shall design the steel joists and/or steel joist girders in accordance with the current SJI specifications and load tables to support the load requirements of Section 2206.2. The registered design professional may require submission of the steel joist and joist girder calculations as prepared by a registered design professional responsible for the product design. If requested by the registered design professional, the steel joist manufacturer shall submit design calculations with a cover letter bearing the seal and signature of the joist manufacturer's registered design professional. In addition to standard calculations under this seal and signature, submittal of the following shall be included:

1. Non-SJI standard bridging details (e.g. for cantilevered conditions, net uplift, etc.).

2. Connection details for:

   2.1. Non-SJI standard connections (e.g. flush-framed or framed connections);

   2.2. Field splices; and

   2.3. Joist headers.

2206.4 Steel joist drawings. Steel joist placement plans shall be provided to show the steel joist products as specified on the construction documents and are to be utilized for field installation in accordance with specific project requirements as stated in Section 2206.2. Steel placement plans shall include, at a minimum, the following:

1. Listing of all applicable loads as stated in Section 2206.2 and used in the design of the steel joists and joist girders as specified in the construction documents.

2. Profiles for nonstandard joist and joist girder configurations (standard joist and joist girder configurations are as indicated in the SJI catalog).

3. Connection requirements for:

   3.1. Joist supports;

   3.2. Joist girder supports;

   3.3. Field splices; and

   3.4. Bridging attachments.

4. Deflection criteria for live and total loads for non-SJI standard joists.

5. Size, location and connections for all bridging.

6. Joist headers.

Steel joist placement plans do not require the seal and signature of the joist manufacturer's registered design professional.

2206.5 Certification. At completion of fabrication, the steel joist manufacturer shall submit a certificate of compliance in accordance with Section 1704.2.2 stating that work was performed in accordance with approved construction documents and with SJI standard specifications.

SECTION 2207
STEEL CABLE STRUCTURES

2207.1 General. The design, fabrication and erection including related connections, and protective coatings of steel cables for buildings shall be in accordance with ASCE 19.

2207.2 Seismic requirements for steel cable. Reserved.

SECTION 2208
STEEL STORAGE RACKS

2208.1 Storage racks. The design, testing and utilization of industrial steel storage racks shall be in accordance with the RMI *Specification for the Design, Testing and Utilization of Industrial Steel Storage Racks.* Racks in the scope of this specification include industrial pallet racks, movable shelf racks and stacker racks, and does not apply to other types of racks, such as drive-in and drive-through racks, cantilever racks, portable racks or rack buildings.

SECTION 2209
COLD-FORMED STEEL

2209.1 General. The design of cold-formed carbon and low-alloy steel structural members shall be in accordance with AISI-NAS. The design of cold-formed stainless-steel structural members shall be in accordance with ASCE 8. Cold-formed steel light-framed construction shall comply with Section 2210.

2209.2 Composite slabs on steel decks. Composite slabs of concrete and steel deck shall be designed and constructed in accordance with ASCE 3.

SECTION 2210
COLD-FORMED STEEL LIGHT-FRAMED CONSTRUCTION

2210.1 General. The design, installation and construction of cold-formed carbon or low-alloy steel, structural and nonstructural steel framing shall be in accordance with AISI-General and AISI-NAS.

2210.2 Headers. The design and installation of cold-formed steel box headers, back-to-back headers and single and double L-headers used in single-span conditions for load-carrying purposes shall be in accordance with AISI-Header, subject to the limitations therein.

2210.3 Trusses. The design, quality assurance, installation and testing of cold-formed steel trusses shall be in accordance with AISI-Truss, subject to the limitations therein.

2210.4 Wall stud design. The design and installation of cold-formed steel studs for structural and nonstructural walls shall be in accordance with AISI-WSD.

2210.5 Lateral design. The design of light-framed cold-formed steel walls and diaphragms to resist wind loads shall be in accordance with AISI-Lateral.

2210.6 Prescriptive framing. Detached one- and two-family dwellings and townhouses, up to two stories in height, shall be permitted to be constructed in accordance with AISI-PM, subject to the limitations therein.

SECTION 2211
GABLE END WALLS

2211.1 Gable end walls. Gable endwalls shall be structurally continuous between points of lateral support.

2211.2 Cathedral end walls. Gable endwalls adjacent to cathedral ceilings shall be continuous from the uppermost floor to ceilings shall be continuous from the uppermost floor to ceiling diaphragm or to the roof diaphragm.

SECTION 2212 - 2213
RESERVED

SECTION 2214
HIGH-VELOCITY HURRICANE ZONES—GENERAL—STEEL CONSTRUCTION

2214.1 Design. Steel and iron members shall be designed by methods admitting of rational analysis according to established principles or methods.

2214.2 The design, fabrication and erection of iron and steel for buildings and other structures shall be as set forth in this Chapter. The requirements set forth in Sections 2215 through 2221 herein, inclusive, apply to structural steel for buildings and other structures. Sections 2222 and 2223, apply to cold-formed members of sheet or strip steel and light-gauge steel construction.

2214.3 The following standards, as set forth in Chapter 35 of this code, are hereby adopted.

1. American Institute of Steel Construction, AISC:
   a. Manual of Steel Construction, Allowable Stress Design ASD, AISC, including Supplement No.1 to the *Specification for Structural Steel Buildings*, 2001.
   b. Manual of Steel Construction, Load Resistance Factor Design LRFD, AISC.
   c. Simple Shear Connection, ASD, AISC.
   d. Simple Shear Connections, LRFD, AISC.
   e. Serviceability Design Considerations for Low-Rise Buildings, AISC.
   f. Plastic Design in Steel, AISC.
   g. Engineering for Steel Construction, AISC.
   h. Detailing for Steel Construction, AISC.
   i. Iron and Steel Beams - 1873 to 1952, AISC.
   j. Plastic Design of Braced Multistory Steel Frames, AISC.
   k. Torsional Analysis of Steel Members, AISC.
2. American Iron and Steel Institute, AISI:
   a. Specification for the Design of Cold-Formed Steel Structural Members, AISI.
   b. Fire-Resistant Steel-Frame Construction, AISI.
   c. Fire-Safe Structural Steel – A Design Guide, AISI.
   d. Designing Fire Protection for Steel Trusses, AISI.
   e. Cold-Formed Steel Design Manual, AISI
   f. Specifications for the Design of Light-Gage Cold-Formed Stainless Structural Members, AISI.
   g. Specification for the Criteria for Structural Application of Steel Cables for Buildings, AISI.
   h. Designing Fire Protection for Steel Columns, AISI.
   i. Design Manual for Structural Tubing, AISI.
3. American National Standards Institute/American Society of Civil Engineers, ANSI/ASCE.
   a. Specifications for the Design and Construction of Composite Slabs and Commentary on Specifications for the Design and Construction of Composite Slabs, ANSI/ASCE 3.
   b. Specifications for the Design of Cold-Formed Stainless Steel Structural Members, ANSI/ASCE 8.
   c. Guideline for Structural Condition Assessment of Existing Buildings, ANSI/ASCE 11.
4. American National Standards Institute/American Welding Society, ANSI/AWS.
   a. *Standard Welding Procedure and Performance Qualification,* AWS B2.1.
   b. *Recommended Practice for Stud Welding,* AWS C5.4.
   c. *Structural Welding Code - Steel*, ANSI/AWS D1.1.
   d. *Structural Welding Code - Sheet Metal*, AWS D1.3.
   e. *Structural Welding Code – Reinforcing Steel,* ANSI/AWS D1.4
   f. *Specification for Welding of Sheet Metal*, AWS D9.1.
   g. *Standard for Qualification of Welding Procedures and Welders for Piping and Tubing*, AWS D10.9.
5. American Society for Testing and materials, ASTM.
   a. *Standard Specification for General Requirements for Rolled Steel Plates, Shapes, b. Sheet Piling and Bars for Structural Use*, ASTM A 6.
   b. *Standard Specifications for High-Strength Bolts for Structural Steel Joints,* ASTM A 325.

c. *Standard Specification for Heat-Treated Steel Structural Bolts. 150 KSI Minimum Tensile Strength*, ASTM A 490.

d. *Standard Specification for General Requirements for Steel Sheet, Zinc Coated (Galvanized) by the Hot Dip Process*, ASTM A 525.

6. National Association of Architectural Metal Manufacturers, NAAMM.

a. *Metal Grating Manual*, NAAMM.

7. Rack Manufacturers Institute/American National Standards Institute, RMI/ANSI.

a. *Industrial Steel Storage Racks Manual,* RMI.

b. *Manual of Safety Practices - A code of Practices for the Use of Industrial and Commercial Steel Storage Racks,* RMI/ANSI MH16.2.

8. Research Council on Structural Connections of the Engineering Foundation, RCSCEF.

a. *Specification for Structural Joints Using ASTM A 325 or A 490 Bolts,* RCSCEF.

9. Shelving Manufacturers Association, a Products Section of the Material Handling Institute/American National Standards Institute, SMA/ANSI.

a. *Specification for the Design, Testing, Utilization and Application of Industrial Grade Steel Shelving*, SMA/ANSI MH281.

10. Steel Deck Institute, Inc., SDI.

a. *Standard Practice Details*, SDI.

b. *SDI Manual of Construction with Steel Deck,* SDI.

c. *Deck Damage and Penetrations,* SDI.

d. *Steel Deck Institute Design Manual.*

e. *LRFD Design Manual for Composite Beams and Girders with Steel Deck,* SDI.

f. *Diaphragm Design Manual,* SDI.

11. Steel Joist Institute, SJI.

a. *Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders,* SJI.

b. *Structural Design of Steel Joist Roofs to Resist Ponding Loads, Technical Digest No. 3*, SJI.

c. *Vibration of Steel Joist-Concrete Slab Floors, Technical Digest No. 5*, SJI.

d. *Structural Design of Steel Joist Roofs to Resist Uplift Loads, Technical Digest No. 6,* SJI.

e. *Welding of Open Web Steel, Technical Digest No. 8*, SJI.

f. *Handling and Erection of Steel Joists and Joist Girders, Technical Digest No. 9,* SJI.

g. *60-Year Steel Joist Manual,* SJI.

12. Steel Structures Painting Council, SSPC.

a. *Steel Joist Shop Paint, SSPC* - Paint 15.

b. *A Guide to the Shop Painting of Structural Steel, SSPC/AISC.*

13. Underwriters Laboratories, Inc., UL.

a. *Test for Uplift Resistance of Roof Assemblies,* UL 580.

14. Welded Steel Tube Institute, Inc., WSTI.

a. *Manual of Cold Formed Welded Structural Steel Tube.*

2214.4 Workmanship. Steel construction shall be in conformance with the tolerances, quality and methods of construction as set forth in Section 2214.3.

2214.5 Statements of the structural responsibilities of architects and professional engineers on the design of structural steel systems.

2214.5.1 The structural engineer of record and/or the architect of record shall be responsible for all aspects of the structural design including the design of components and connections. The structural construction documents may assign to the fabricator the responsibility for implementing the design as specified and for maintaining fabrication and erection tolerances and for ensuring the fit and erectability of the structure.

2214.5.2 The structural engineer of record and/or the architect of record may elect to detail all connections on the structural construction documents and require fabrication in accordance with those details.

2214.5.3 Alternately the structural engineer of record and/or the architect of record may permit the fabricator to select or modify connections subject to review and approval by the structural engineer of record and/or the architect of record. In that case, the structural construction documents shall specify criteria for the design of connections and shall identify the nature, magnitude and location of all design loads.

2214.5.4 The structural engineer of record and/or the architect of record shall require the submission of fabrication and erection drawings for review as an indication that his or her intent has been understood and the specified criteria have been used.

2214.5.5 Structural submittals requiring engineering input, such as dealing with substitute connections, shall be accompanied by design calculations and shall bear the impressed seal, signature and date of the specialty engineer who prepared them.

SECTION 2215 HIGH-VELOCITY HURRICANE ZONES—MATERIAL

2215.1 Steel. Steel shall conform to the physical requirements set forth in the applicable standard in Section 2214.3.

2215.2 High-strength steel bolts. High-strength steel bolts shall conform to the requirements set forth in the applicable standards of Section 2214.3.

2215.3 Used and damaged material. All steel shall be straight and true, and any section damaged to be out of shape shall not be used. Steel previously used or fabricated for use or fabricated in error shall not be used except with the approval of the building official. Filled holes or welds shall not be concealed. Straightened or retempered fire-burned steel shall not be used except with the approval of the building official.

2215.4 Tests. The building official may require tests and/or mill records to determine the quality of materials.

2215.5 Ribbed bolts. Ribbed bolts shall be made from carbon manganese steel with a minimum tensile strength of 70,000 per square inch (482.7 MPa).

SECTION 2216 HIGH-VELOCITY HURRICANE ZONES— DESIGN LOADS

2216.1 Design shall be based on the dead, live, wind and other loads set forth in Chapter 16 (High-Velocity Hurricane Zones) and the additional stress considerations set forth in this Chapter.

SECTION 2217 HIGH-VELOCITY HURRICANE ZONES— MINIMUM THICKNESS OF MATERIAL

2217.1 The minimum thickness of material shall not be less than as set forth in the applicable standards listed in Section 2214.3 except as otherwise set forth herein.

SECTION 2218 HIGH-VELOCITY HURRICANE ZONES— CONNECTIONS

2218.1 Connections shall conform to the requirements of the applicable standards set forth in Section 2214.3.

2218.2 A Florida-registered architect or professional engineer shall inspect the welding and high-strength bolting of structural steel framing and welding, bolting and fastening of lightweight material systems and metal sidings of buildings with areas exceeding 1,000 square feet (93 m^2).

2218.3 Welding in the shop or field may be done only by AWS certified welders.

SECTION 2219 HIGH-VELOCITY HURRICANE ZONES— TUBULAR COLUMNS

2219.1 Tubular columns and other primary compression members, excluding secondary posts and struts not subject to bending and whose design load does not exceed 2,000 pounds (8900 N), shall have a minimum least dimension of $2^1/_2$ inches (64 mm) and a minimum wall thickness of $^3/_{16}$ inch (4.8 mm).

2219.2 Tubular members when filled with concrete shall have $^1/_4$-inch diameter (6.4 mm) pressure relief holes drilled through the shell, within 6 inches (152 mm) of the top and bottom of the exposed length of the member and one hole at midheight.

2219.3 Concrete fill in tubular members shall not be assumed to carry any of the load except in compression members having a least dimension of 8 inches (203 mm) or greater and having a 1 inch (25 mm) inspection hole in the plate at each end.

SECTION 2220 HIGH-VELOCITY HURRICANE ZONES— PROTECTION OF METAL

2220.1 All field rivets, bolts, welds and abrasions to the shop coat shall be spot painted or treated with the material used for the shop coat, or an equivalent comparable to the shop coat, after removal of all objectionable deleterious materials.

2220.2 Primary structural steel members, except where intended to be encased in concrete, shall have one shop coat of paint and, if exposed to the atmosphere or elements in the completed building or structure shall receive a second shop coat of paint or be field painted in addition to the initial shop coat with lead, graphite or asphalt paint or other approved coating compatible with the shop coat, except as herein provided. Surfaces of members in contact with, but not encased in, concrete or masonry shall be asphalt coated or otherwise effectively coated where the thickness of the metal is $^3/_{16}$ inch (4.8 mm) or less.

2220.3 Members having a corrosion-resistive metallic coating of zinc of not less than G90 Coating Designation (1.25 ounces; 35 grams) or other equivalent approved coating are not required to have the shop and field coating.

2220.4 Where structural members are exposed to industrial fumes, fresh and/or salt water, salt water spray, and other corrosive agents, such members shall be effectively protected with a corrosion-resistive metallic or other equivalent approved coating.

2220.5 Corrosion-resistant steels with or without painting or coating may be approved where sufficient test or other factual data establishing the satisfactory performance under the particular exposure conditions or usage is submitted to and approved by the building official.

SECTION 2221 HIGH-VELOCITY HURRICANE ZONES— GENERAL—OPEN WEB STEEL JOISTS

2221.1 Standards. Open web steel joists shall comply with the standards set forth in Section 2214.3.

2221.2 Statements of responsibilities of architects and professional engineers on the design of structural systems using open web steel joists.

2221.2.1 The structural construction documents shall designate the standards for joist design and shall indicate layout, end supports, anchorage, bridging requirements, etc., including connections to walls. The structural construction documents shall indicate special requirements for concentrated loads, openings, extended ends and resistance to uplift.

2221.2.2 The structural engineer of record and/or the architect of record shall require structural submittals for the structural engineer of record's review and/or the architect of record's review as an indication that his or her intent has been understood and that the specified criteria have been used. The structural submittals, unless catalog submittals, shall bear the impressed seal, signature and date of the specialty engineer who prepared them.

2221.2.3 The structural submittals shall identify the specific project, shall list the design criteria and shall show all joist location information and details necessary for proper installation.

2221.3 Design.

2221.3.1 Open web steel joist systems shall be designed to accommodate the loads and forces set forth in Chapter 16 (High-Velocity Hurricane Zones).

2221.3.2 Net uplift forces for all zones, applied to the joist systems, shall be clearly indicated on the structural construction documents.

2221.3.3 Where the net uplift force is equal to or greater than the gravity load of construction, all web and bottom chord members shall comply with slenderness ratio requirements for top chord and for compression members other than top chord as provided for in the standards set forth in Section 2214.3(11).

2221.3.4 The slenderness ratio about the horizontal axis can be used in determining the capacity of the top chord provided the top chord is stayed laterally by the deck system. The top chord for superimposed dead and live loads shall be considered to be stayed laterally if:

1. A poured-in-place concrete slab is in direct contact with the top chord.
2. A light gauge steel deck complying with Section 2222 is fastened to the top chord.
3. Any other approved deck system such that attachments of the top chord to the deck are capable of resisting a lateral force specified in the standard set forth in Section 2214.3 and the spacing of the fasteners does not exceed 24 inches (610 mm) along the chord.

2221.3.5 When the bottom chord under net uplift loads is in compression, the bottom chord shall be stayed laterally by a bracing system adequately anchored at each end.

2221.3.6 Fastenings shall be bolting, welding or other approved fastening device that provides a resistance to lateral movement as required by rational analysis or by test, but not less than 400 pounds per foot (5838 N/m).

2221.4 Connections. The joints and connections of members of steel joists shall be made by welding or bolting.

2221.5 Bridging.

2221.5.1 All bridging and anchors shall be completely installed before application of any construction loads. Bridging shall secure the chords against lateral movement and shall position and hold the joists vertical and in a straight line.

2221.5.2 Bridging members shall be of material having a thickness not less than:

1. $^{1}/_{8}$ inch (3.2 mm) for hot-rolled sections.
2. 16 gauge for cold-formed sections.
3. $^{1}/_{2}$ inch (12.7 mm) diameter for round members.

2221.5.3 Bridging shall be connected to the chords of the joists by welding, bolting or other positive mechanical means. Each attachment shall be capable of resisting a horizontal force specified in the standard set forth in Section 2214.3.

2221.5.4 Bridging shall be connected to the chords of the joists by bolting or welding at all points of contact and shall be capable of transmitting the forces required of the bridging members. The ends of all bridging lines shall terminate at walls or beams and shall be anchored thereto and where anchorage is not possible, stability shall be provided by additional bracing.

2221.5.5 Where uplift forces are a design requirement, a single line of continuous bottom chord bridging shall be provided near the first panel points.

2221.6 End supports and anchorage.

2221.6.1 Joists shall not bear directly on unit masonry unless masonry is designed as engineered unit masonry with properly reinforced, grout-filled continuous bond beam.

2221.6.2 The ends of every joist shall be bolted, welded or encased in concrete at each point of bearing to provide not less resistance in any direction than 50 percent of the Steel Joist Institute (SJI) rated end reaction horizontally and 100 percent of the net uplift reaction specified in the structural construction documents.

2221.6.3 The ends of joists shall have a minimum bearing, on reinforced concrete and steel supports as specified in the standard set forth in Section 2214.3(11).

2221.7 Fabrication. Steel joists shall be manufactured by plants having a certificate of competency issued by the authority having jurisdiction.

2221.8 Shop standards. The applicant for building permit will not be required to submit shop drawings for steel joists except as set forth in Sections 2221.8.1 and 2221.8.2.

2221.8.1 The master permit drawings required by this code shall describe all steel to be used in the proposed building or structure, including open-web frames and trusses, and shall detail member sizes, spacing, attachment and welding including provision for unusual loading such as concentrated loads, unusual cantilevering, soffit framing and continuity except that such prime drawings may designate standard open-web steel joists by Steel Joist Institute (SJI) number and symbol.

2221.8.2 Where standard open-web steel joists are designated on the prime drawings by customary SJI numbers or symbols, the manufacturer, fabricator or supplier may be required to submit design computations, stress diagrams, sizes of members and sizes of welds to the building official for approval before installation to demonstrate that the units to be provided do, in fact, comply with the specifications and performance standards set forth by SJI. Only design computations prepared by a professional engineer will be accepted. Resubmission of any fabricator designs so submitted and approved will not be required for each subsequent job. Proof of the characteristics of the material may be required for any steel for which a minimum yield strength in excess of 36,000 per square inch (248.2 MPa) is used as the basis of design.

SECTION 2222 HIGH-VELOCITY HURRICANE ZONES— COLD-FORMED STEEL CONSTRUCTION

2222.1 Cold-formed steel construction shall include individual structural members, structural decks or wall panels, and nonstructural roofing, siding and other construction elements formed from sheet or strip steel and as set forth in Section 2214.3(2).

2222.2 Standards. Cold-formed steel used in structural applications shall conform to the Standards set forth in Section 2214.3(2).

2222.2.1 Galvanizing as referred to herein is to be zinc coating conforming to the standard set forth in Section 2214.3(5)(d).

2222.3 Individual structural members. Design, fabrication and erection of individual cold-formed steel structural members shall be as set forth herein.

2222.3.1 All structural members shall be positively connected to resist the loads set forth in Chapter 16 (High-Velocity Hurricane Zones).

2222.3.2 All connections shall be by welding, riveting, bolting or other approved fastening devices or methods providing positive attachment and resistance to loosening. Fasteners shall be of compatible material.

2222.3.3 Cables and rods shall not be used as lateral bracing in habitable structures. Lateral bracing, when used, shall have a slenderness ratio of 300 or less, unless restricted by any other section of this code.

2222.3.4 Doors and windows in preengineered metal building systems shall be designed as a structural component member and shall conform to all requirements in this chapter.

2222.3.5 All doors shall be anchored as part of the frame in the closed position.

2222.3.6 No increase in strength shall be allowed for the effect of cold work.

2222.4 Structural sheets. Decks and panels with or without an approved fill material may be designed as diaphragms in accordance with *Diaphragm Design Manual of the Steel Deck Institute*, provided other limitations in this code are complied with.

2222.4.1 Poured fill on roof and floor decks shall not be assumed to have any structural value to support or resist vertical or lateral loads or to provide stability or diaphragm action unless so designed, and poured fill and/or applied materials do not degrade when subjected to moisture.

2222.4.2 Positive attachment of sheets shall be provided to resist uplift forces. Attachment shall be as set forth in Section 2222.3.1 and as required by rational analysis, and/or tests, but not less frequently than the following maximum spacing:

1. One fastener shall be placed near the corner of each sheet or at overlapping corners of sheets.
2. Along each supporting member, the spacing of fasteners shall not exceed 8 inches (203 mm) on centers at ends of sheets or 12 inches (305 mm) on centers.
3. The spacing of edge fasteners between panels, and between panels and supporting members, parallel to the direction of span, where continuous interlock is not otherwise provided shall be not more than 12 inches (305 mm) on centers.
4. Fastening shall be by bolting, welding or other approved fastening device that provides a resistance to lateral movement as required by rational analysis or by test, but not less than 400 pounds per lineal foot (5838 N/m).
5. Poured lightweight concrete fill will be acceptable as continuous interlock.
6. Attachment to the supporting structure shall be provided at all perimeters and discontinuities by fasteners spaced at no more than 8 inches (203 mm) on center.
7. Wall panels shall be attached as set forth in Section 2222.4.2(1),(2) and (3).

2222.4.3 Metal siding and roof panels shall be not less than 24 gauge.

Exception: Roof panels having an approved fill material designed to act as a diaphragm may use a lighter deck gauge provided that the product approval for the fill material allows its use over the same deck gauge, but in no case shall the deck be less than 26 gauge. The permit applicant shall provide the building official with signed and sealed structural calculations for the diaphragm design prepared by a licensed architect or engineer proficient in structural design. The diaphragm design shall comply with the applicable requirements of Chapter 16 and Chapter 22 (High-Velocity Hurricane Zones).

2222.4.4 Deflection of metal siding and roof panels shall not exceed L/240.

2222.4.5 The bending stress of metal siding and roof panels shall be designed using a safety factor of not less than 2.5.

2222.4.6 Minimum roof decking uplift loads shall comply with the design requirements of Chapter 16 (High-Velocity Hurricane Zones) utilizing rational analysis, but not less than UL 580 Class 90.

2222.4.7 Reserved.

2222.4.8 Metal siding and roof panels shall be designed, where possible, to be continuous over two or more spans.

2222.5 Nonstructural sheets. Steel sheet sections not suitable by rational analysis for self-supporting structural sheets shall be termed roofing and siding. Roofing and siding shall be used only over solid wood sheathing or equivalent backing.

2222.5.1 Attachment of sheets shall be as set forth in Section 2222.4.2

2222.6 Protection of metal. All members shall be treated with protective paint coatings or equivalent protection except as permitted in Sections 2222.6.1 or 2222.6.2.

2222.6.1 All steel sheets having a thickness of less than 20 gauge, i.e., materials of higher gauge, shall be galvanized in accordance with the standards of Section 2214.3(5)(d) herein to provide a minimum coating designation of G90.

2222.6.2 Abrasions or damages to the protective coating shall be spot-treated with a material and in a manner compatible to the shop protective coating.

2222.7 Welding shall conform to the requirements of Sections 2214.3, 2218.2 and 2218.3.

SECTION 2223 HIGH-VELOCITY HURRICANE ZONES— PRE-ENGINEERED, PREFABRICATED METAL BUILDING SYSTEMS AND COMPONENTS (PRE-ENGINEERED STRUCTURES)

2223.1 Scope. Metal buildings (preengineered structures) shall include, but not be limited to, tapered or straight web structural steel frames and predominantly cold formed steel secondary components, including, but not limited to, girts, purlins, roof sheets, wall sheets, etc.

2223.2 Standards. Frames and components shall comply with the standards set forth in Section 2214.3.

2223.3 Structural construction documents for pre-engineered structures shall indicate the necessary measures for adapting the structures to the specific site. The structural construction documents shall indicate all openings, concentrated loads and other special requirements. Foundation conditions assumed in the design shall be indicated as well as the location and magnitude of building reactions on that foundation under all design conditions.

2223.4 Structural submittals.

2223.4.1 The structural engineer of record and/or the architect of record shall require structural submittals for review as an indication that his or her intent has been understood and that the specified criteria have been used. The structural submittals shall bear the impressed seal, signature and date of the specialty engineer who prepared them.

2223.4.2 The structural submittals shall identify the project and list loading and other design criteria. The fabrication and erection drawings shall indicate in detail the construction of the standard structure used or as modified to comply with the requirements of the particular project. The fabrication and erection drawings shall indicate all connection details, openings and other special details. The fabrication and erection drawings shall show the magnitude and location of building reactions on the foundation under all design conditions. Calculations supporting the design shall be submitted not only for the standard structure, but also for modifications and for related components requiring structural design.

2223.5 Design. A building or component system in this section shall have a structural engineer of record and/or architect of record responsible for the overall design and performance of the entire building including the foundation and the anchorage of the preengineered metal systems buildings thereto. The structural engineer of record and/or the architect of record shall provide the structural construction documents necessary for permitting.

2223.5.1 Calculations for drift and deflection of the metal system building shall be by the specialty engineer.

2223.5.2 Calculations for deflection shall be done using only the bare frame method. Reductions based on engineering judgment using the assumed composite stiffness of the building envelope shall not be allowed. Drift shall follow AISC serviceability design considerations for low-rise buildings. The use of composite stiffness for deflection calculations shall be permitted only when actual calculations for the stiffness are included with the design for the specific project. When maximum deflections are specified by the structural construction documents, calculations shall be included in the design data.

2223.5.3 The manufacturer shall design the metal system building and/or component system in accordance with the provisions of Chapter 16 (High-Velocity Hurricane Zones), and the design shall be signed, dated and sealed by the specialty engineer and reviewed by the structural engineer of record and/or the architect of record. The manufacturer of the metal system building and or component system shall be responsible to provide all reactions to the structural engineer of record and/or the architect of record.

2223.5.4 Fastenings shall be by bolting, welding or other approved fastening device that provides a resistance to lateral movement as required by rational analysis or by test, but not less than 400 pounds per lineal foot (5838 N/m).

2223.6 Permitting.

2223.6.1 The applicant for a building permit will be required to submit structural construction documents indicating the overall building dimensions, haunch and eave heights, roof slopes, bay spacing, column locations, approximate frame and component profiles, foundation details and fire rating details and the magnitude and location of building reactions on the foundation under all design conditions prior to the issuance of the permit.

2223.6.2 Prior to the commencement of erection of the structure, the structural submittal and calculations, including, but not limited to, fabrication and erection drawings signed, dated and sealed by the specialty engineer and reviewed by the architect of record and/or the structural engineer of record, shall be submitted and approved by the building department.

2223.6.3 Where the roofing and siding are structural sheets consisting of clip-mounted standing seam or other direct screw attached panel system and are in themselves the finished product, a separate roofing permit shall not be required.

2223.7 Fabrication and erection.

2223.7.1 Fabrication shall be done in accordance with the standards mentioned above. The manufacturer shall provide a letter certifying that the building has been designed and fabricated in accordance with the above referenced standards.

2223.7.2 Temporary bracing shall be provided during erection and shall remain in place until all structural frames, purlins, girts, flange braces, cable or rod bracing and sheets used as diaphragms have been installed,

2223.8 Roof sheets, wall sheets, roof panels and wall panels.

2223.8.1 All building envelope components shall have Product Approval.

2223.8.2 The fusion welding of structural members and structural sheets defined in Section 2222.4 and less than 22 gauge (0.0299 inch nominal) in thickness shall have minimum of $^5/_8$ inch (17 mm) diameter welds through weld washers not less than 14-gauge in thickness and 1 inch (25 mm) in diameter, contoured if necessary to provide continuous contact, or an equivalent device.

2223.8.3 Clip-mounted standing-seam roof sheets shall not be used as diaphragms nor shall they be considered as adequate lateral bracing of the flange of the secondary member to which they are attached unless one or both of these features are designed into the sheathing system and the manufacturer can certify by testing and/or analysis that such capabilities exist and are appropriately defined.

2223.8.4 Structural standing-seam roof sheets shall be a minimum of 24 gauge [0.0239 inch (.6 mm) nominal] in thickness.

2223.8.5 Direct screw attached roof and wall sheets may be used as diaphragms provided the sheets are a minimum of 24 gauge [0.0239 inch (.6 mm) nominal] in thickness. Additionally, these sheets shall be considered to laterally brace the flange of the secondary member to which they are attached.

2223.8.6 See Section 2222 for additional requirements for roof sheets, wall sheets, roof panels and wall panels.

2223.9 Roof purlins and wall girts.

2223.9.1 Adequate bracing shall be provided to the compression flanges of secondary members with special attention to those members subject to uplift or outward pressures where no roof or wall sheets are attached to provide such bracing. Sag rods shall not be considered bracing when located in the neutral axis of the web of the secondary members.

2223.9.2 Roof purlins and wall girts shall be laterally braced in addition to relying on deck and panel diaphragm action.

2223.9.3 The ends and bearing points of secondary members shall be designed to carry 100 percent of dead, live and collateral loads superimposed on them by wind.

2223.9.4 Upward or outward forces of wind are to be calculated without live and collateral loads. When downward or inward forces caused by wind are involved, the dead forces plus collateral load forces must be combined but the roof live load may be omitted.

2223.10 Individual structural members.

2223.10.1 Cables and rods shall not be used as lateral bracing in habitable structures. Lateral bracing, when used, shall have a slenderness ratio of 300 or less, unless restricted by any other section of this code.

2223.10.2 Doors and windows in preengineered metal building systems shall have Product Approval.

2223.10.3 All doors shall be anchored as part of the frame in the closed position.

2223.10.4 No increase in strength shall be allowed for the effect of cold work.

2223.10.5 See Section 2222 for additional requirements for pre-engineered metal building systems and components.

2223.11 Inspection.

2223.11.1 Metal system buildings shall be inspected by a Florida-registered architect or professional engineer.

2223.11.2 Metal systems building construction shall comply with the requirements of the AISC Metal Building Certification Program, Category MB Certified.

2223.11.3 Letter of certification. The metal systems building manufacturer shall submit a written certification prepared, signed, dated and sealed by the specialty engineer registered to practice in the State of Florida verifying that the building system design and metal wall and roof system design including, but not limited to, panels, clips, support system components, etc., meet the indicated loading requirements and codes of the authorities having jurisdiction. The certification shall reference specific dead loads, live loads, wind loads/speeds, tributary area load reductions (if applicable), collateral loads, end use categories, crane loads, accessory loads, load combinations, governing code bodies including year and load applications. The letter of certification shall be provided to the structural engineer of record and/or the architect of record, the special inspector and the building department prior to the issuance of the certificate of occupancy.

2223.11.4 Structural construction documents demonstrating compliance with this code shall be reviewed and approved by the special inspector prior to the issuance of a certificate of occupancy.

SECTION 2224
HIGH-VELOCITY HURRICANE ZONES—CHAIN LINK FENCES

2224.1 Chain link fences in excess of 12 feet (3.7 m) in height shall be designed according to the loads specified in Chapter 16 (High-Velocity Hurricane Zones).

2224.2 Chain link fences less than 12 feet (3.7 m) in height shall be designed according to the loads specified in Chapter 16 (High-Velocity Hurricane Zones) or may be constructed to meet the minimum requirements specified in Table 2224.

**TABLE 2224
CHAIN LINK FENCE MINIMUM REQUIREMENTS**

Fence Height (ft)	Terminal Post Dimensions (in inches) (o.d. x wall thickness)	Line Post Dimensions (o.d. x wall thickness) (in inches)	Terminal Post Concrete Foundation Size (diameter x depth) (in inches)	Line Post Concrete Foundation Size (diameter x depth) (in inches)
Up to 4	2 3/8 x 0.042	1 5/8 x 0.047	10 x 24	8 x 24
Over 4 to 5	2 3/8 x 0.042	1 7/8 x 0.055	10 x 24	8 x 24
Over 5 to 6	2 3/8 x 0.042	1 7/8 x 0.065	10 x 24	8 x 24
Over 6 to 8	2 3/8 x 0.110	2 3/8 x 0.095	10 x 36	10 x 36
Over 8 to 10	2 7/8 x 0.110	2 3/8 x 0.130	12 x 40	10 x 40
Over 10 to 12	2 7/8 x 0.160	2 7/8 x 0.120	12 x 42	12 x 42

For SI: 1 inch = 25.4 mm.
NOTES:
1. This table is applicable only to fences with unrestricted airflow.
2. Fabric: 121/2 gauge minimum.
3. Tension bands: Use one less than the height of the fence in feet evenly spaced.
4. Fabric ties: Must be minimum the same gauge of the fabric.
5. Fabric tie spacing on the top rail: Five ties between posts, evenly spaced.
6. Fabric tie spacing on line posts: One less than height of the fence in feet, evenly spaced.
7. Either top rail or top tension wire shall be used.
8. Braces must be used at terminal posts if top tension wire is used instead of top rail.
9. Post spacing: 10 foot (3 m) on center maximum.
10. Posts shall be embedded to within 6 inches (152 mm) from the bottom of the foundation.
11. In order to follow the contour of the land, the bottom of the fence may clear the contour of the ground by up to 5 inches (127 mm) without increasing table values to the next higher limit.

CHAPTER 23
WOOD

SECTION 2301
GENERAL

2301.1 Scope. The provisions of this chapter shall govern the materials, design, construction and quality of wood members and their fasteners.

> **Exception:** Buildings and structures located within the high-velocity hurricane zone shall comply with the provisions of Sections 2314 through 2330.

2301.2 General design requirements. The design of structural elements or systems, constructed partially or wholly of wood or wood-based products, shall be in accordance with one of the following methods:

1. Allowable stress design in accordance with Sections 2304, 2305 and 2306.
2. Load and resistance factor design in accordance with Sections 2304, 2305 and 2307.
3. Conventional light-frame construction in accordance with Sections 2304 and 2308.

   Exception: Buildings designed in accordance with the provisions of the AF&PA WFCM shall be deemed to meet the requirements of the provisions of Section 2308.

2301.3 Nominal sizes. For the purposes of this chapter, where dimensions of lumber are specified, they shall be deemed to be nominal dimensions unless specifically designated as actual dimensions (see Section 2304.2).

SECTION 2302
DEFINITIONS

2302.1 Definitions. The following words and terms shall, for the purposes of this chapter, have the meanings shown herein.

ACCREDITATION BODY. An approved, third-party organization that is independent of the grading and inspection agencies, and the lumber mills, and that initially accredits and subsequently monitors, on a continuing basis, the competency and performance of a grading or inspection agency related to carrying out specific tasks.

BRACED WALL LINE. A series of braced wall panels in a single story that meets the requirements of Section 2308.3.

BRACED WALL PANEL. A section of wall braced in accordance with Section 2308.9.3.

COLLECTOR. A horizontal diaphragm element parallel and in line with the applied force that collects and transfers diaphragm shear forces to the vertical elements of the lateral-force-resisting system and/or distributes forces within the diaphragm.

CONVENTIONAL LIGHT-FRAME WOOD CONSTRUCTION. A type of construction whose primary structural elements are formed by a system of repetitive wood-framing members. See Section 2308 for conventional light-frame wood construction provisions.

CRIPPLE WALL. A framed stud wall extending from the top of the foundation to the underside of floor framing for the lowest occupied floor level.

DIAPHRAGM, UNBLOCKED. A diaphragm that has edge nailing at supporting members only. Blocking between supporting structural members at panel edges is not included. Diaphragm panels are field nailed to supporting members.

DRAG STRUT. See "Collector."

FIBERBOARD. A fibrous, homogeneous panel made from lignocellulosic fibers (usually wood or cane) and having a density of less than 31 pounds per cubic foot (pcf) (497 kg/m^3) but more than 10 pcf (160 kg/m^3).

GLUED BUILT-UP MEMBER. A structural element, the section of which is composed of built-up lumber, wood structural panels or wood structural panels in combination with lumber, all parts bonded together with structural adhesives.

GRADE (LUMBER). The classification of lumber in regard to strength and utility in accordance with American Softwood Lumber Standard DOC PS 20 and the grading rules of an approved lumber rules-writing agency.

HARDBOARD. A fibrous-felted, homogeneous panel made from lignocellulosic fibers consolidated under heat and pressure in a hot press to a density not less than 31 pcf (497 kg/m^3).

NAILING, BOUNDARY. A special nailing pattern required by design at the boundaries of diaphragms.

NAILING, EDGE. A special nailing pattern required by design at the edges of each panel within the assembly of a diaphragm or shear wall.

NAILING, FIELD. Nailing required between the sheathing panels and framing members at locations other than boundary nailing and edge nailing.

NATURALLY DURABLE WOOD. The heartwood of the following species with the exception that an occasional piece with corner sapwood is permitted if 90 percent or more of the width of each side on which it occurs is heartwood.

> **Decay resistant.** Redwood, cedar, black locust and black walnut.
>
> **Termite resistant.** Redwood and Eastern red cedar.

NOMINAL SIZE (LUMBER). The commercial size designation of width and depth, in standard sawn lumber and glued-laminated lumber grades; somewhat larger than the standard net size of dressed lumber, in accordance with DOC PS 20 for sawn lumber and with the AF&PA NDS for glued-laminated lumber.

PARTICLEBOARD. A generic term for a panel primarily composed of cellulosic materials (usually wood), generally in the form of discrete pieces or particles, as distinguished from fibers. The cellulosic material is combined with synthetic resin or other suitable bonding system by a process in which the interparticle bond is created by the bonding system under heat and pressure.

PREFABRICATED WOOD I-JOIST. Structural member manufactured using sawn or structural composite lumber flanges and wood structural panel webs bonded together with exterior exposure adhesives, which forms an "I" cross-sectional shape.

PRESERVATIVE-TREATED WOOD. Wood (including plywood) pressure treated with preservatives in accordance with Section 2303.1.8.

SHEAR WALL. A wall designed to resist lateral forces parallel to the plane of a wall.

Shear wall, perforated. A wood structural panel sheathed wall with openings, that has not been specifically designed and detailed for force transfer around openings.

Shear wall segment, perforated. A section of shear wall with full-height sheathing that meets the height-to-width ratio limits of Section 2305.3.4.

STRUCTURAL COMPOSITE LUMBER. Structural member manufactured using wood elements bonded together with exterior adhesives. Examples of structural composite lumber are:

Laminated veneer lumber (LVL). A composite of wood veneer sheet elements with wood fibers primarily oriented along the length of the member.

Parallel strand lumber (PSL). A composite of wood strand elements with wood fibers primarily oriented along the length of the member.

STRUCTURAL GLUED-LAMINATED TIMBER. An engineered, stress-rated product of a timber laminating plant, comprised of assemblies of specially selected and prepared wood laminations in which the grain of all laminations is approximately parallel longitudinally and the laminations are bonded with adhesives.

SUBDIAPHRAGM. A portion of a larger wood diaphragm designed to anchor and transfer local forces to primary diaphragm struts and the main diaphragm.

TIE-DOWN (HOLD-DOWN). A device used to resist uplift of the chords of shear walls.

TREATED WOOD. Wood impregnated under pressure with compounds that reduce its susceptibility to flame spread or to deterioration caused by fungi, insects or marine borers.

WOOD SHEAR PANEL. A wood floor, roof or wall component sheathed to act as a shear wall or diaphragm.

WOOD STRUCTURAL PANEL. A panel manufactured from veneers, wood strands or wafers or a combination of veneer and wood strands or wafers bonded together with waterproof synthetic resins or other suitable bonding systems. Examples of wood structural panels are:

Composite panels. A wood structural panel that is comprised of wood veneer and reconstituted wood-based material and bonded together with waterproof adhesive;

Oriented strand board (OSB). A mat-formed wood structural panel comprised of thin rectangular wood strands arranged in cross-aligned layers with surface layers normally arranged in the long panel direction and bonded with waterproof adhesive; or

Plywood. A wood structural panel comprised of plies of wood veneer arranged in cross-aligned layers. The plies are bonded with waterproof adhesive that cures on application of heat and pressure.

SECTION 2303
MINIMUM STANDARDS AND QUALITY

2303.1 General. Structural sawn lumber; end-jointed lumber; prefabricated wood I-joists; structural glued-laminated timber; wood structural panels, fiberboard sheathing (when used structurally); hardboard siding (when used structurally); particleboard; preservative-treated wood; structural log members; structural composite lumber; round timber poles and piles; fire-retardant-treated wood; hardwood plywood; wood trusses; joist hangers; nails; and staples shall conform to the applicable provisions of this section.

2303.1.1 Sawn lumber. Sawn lumber used for load-supporting purposes, including end-jointed or edge-glued lumber, machine stress-rated or machine-evaluated lumber, shall be identified by the grade mark of a lumber grading or inspection agency that has been approved by an accreditation body that complies with DOC PS 20 or equivalent. Grading practices and identification shall comply with rules published by an agency approved in accordance with the procedures of DOC PS 20 or equivalent procedures. In lieu of a grade mark on the material, a certificate of inspection as to species and grade issued by a lumber grading or inspection agency meeting the requirements of this section is permitted to be accepted for precut, remanufactured or rough-sawn lumber and for sizes larger than 3 inches (76 mm) nominal thickness.

Approved end-jointed lumber is permitted to be used interchangeably with solid-sawn members of the same species and grade.

2303.1.2 Prefabricated wood I-joists. Structural capacities and design provisions for prefabricated wood I-joists shall be established and monitored in accordance with ASTM D 5055.

2303.1.3 Structural glued-laminated timber. Glued-laminated timbers shall be manufactured and identified as required in AITC A190.1 and ASTM D 3737.

2303.1.4 Wood structural panels. Wood structural panels, when used structurally (including those used for siding, roof and wall sheathing, subflooring, diaphragms and built-up members), shall conform to the requirements for their type in DOC PS 1 or PS 2. Each panel or member shall be identified for grade and glue type by the trademarks of an approved testing and grading agency. Wood structural panel components shall be designed and fabricated in accordance with the applicable standards listed in Section 2306.1 and identified by the trademarks of an approved testing and inspection agency indicating conformance with the applicable standard. In addition, wood structural panels when permanently exposed in outdoor applications shall be of exterior type, except that wood structural panel roof sheathing exposed to the outdoors on the underside is permitted to be interior type bonded with exterior glue, Exposure 1.

2303.1.5 Fiberboard. Fiberboard for its various uses shall conform to ASTM C 208. Fiberboard sheathing, when used structurally, shall be identified by an approved agency as conforming to ASTM C 208.

2303.1.5.1 Jointing. To ensure tight-fitting assemblies, edges shall be manufactured with square, shiplapped, beveled, tongue-and-groove or U-shaped joints.

2303.1.5.2 Roof insulation. Where used as roof insulation in all types of construction, fiberboard shall be protected with an approved roof covering.

2303.1.5.3 Wall insulation. Where installed and fireblocked to comply with Chapter 7, fiberboards are permitted as wall insulation in all types of construction. In fire walls and fire barriers, unless treated to comply with Section 803.1 for Class A materials, the boards shall be cemented directly to the concrete, masonry or other noncombustible base and shall be protected with an approved noncombustible veneer anchored to the base without intervening airspaces.

2303.1.5.3.1 Protection. Fiberboard wall insulation applied on the exterior of foundation walls shall be protected below ground level with a bituminous coating.

2303.1.6 Hardboard. Hardboard siding used structurally shall be identified by an approved agency conforming to AHA A135.6. Hardboard underlayment shall meet the strength requirements of $^7/_{32}$-inch (5.6 mm) or $^1/_4$-inch (6.4 mm) service class hardboard planed or sanded on one side to a uniform thickness of not less than 0.200 inch (5.1 mm). Prefinished hardboard paneling shall meet the requirements of AHA A135.5. Other basic hardboard products shall meet the requirements of AHA A135.4. Hardboard products shall be installed in accordance with manufacturer's recommendations.

2303.1.7 Particleboard. Particleboard shall conform to ANSI A208.1. Particleboard shall be identified by the grade mark or certificate of inspection issued by an approved agency. Particleboard shall not be utilized for applications other than indicated in this section unless the particleboard complies with the provisions of Section 2306.4.3.

2303.1.7.1 Floor underlayment. Particleboard floor underlayment shall conform to Type PBU of ANSI A208.1. Type PBU underlayment shall not be less than $^1/_4$-inch (6.4 mm) thick and shall be installed in accordance with the instructions of the Composite Panel Association.

2303.1.8 Preservative-treated wood. Lumber, timber, plywood, piles and poles supporting permanent structures required by Section 2304.11 to be preservative treated shall conform to the requirements of the applicable AWPA Standard U1 and M4 for the species, product, preservative and end use. Preservatives shall be listed in Section 4 of AWPA U1. Lumber and plywood used in wood foundation systems shall conform to Chapter 18.

2303.1.8.1 Identification. Wood required by Section 2304.11 to be preservative treated shall bear the quality mark of an inspection agency that maintains continuing supervision, testing and inspection over the quality of the preservative-treated wood. Inspection agencies for preservative-treated wood shall be listed by an accreditation body that complies with the requirements of the American Lumber Standards Treated Wood Program, or equivalent. The quality mark shall be on a stamp or label affixed to the preservative-treated wood, and shall include the following information:

1. Identification of treating manufacturer.
2. Type of preservative used.
3. Minimum preservative retention (pcf).
4. End use for which the product is treated.
5. AWPA standard to which the product was treated.
6. Identity of the accredited inspection agency.

2303.1.8.2 Moisture content. Where preservative-treated wood is used in enclosed locations where drying in service cannot readily occur, such wood shall be at a moisture content of 19 percent or less before being covered with insulation, interior wall finish, floor covering or other materials.

2303.1.9 Structural composite lumber. Structural capacities for structural composite lumber shall be established and monitored in accordance with ASTM D 5456.

2303.1.10 Structural log members. Stress grading of structural log members of nonrectangular shape, as typically used in log buildings, shall be in accordance with ASTM D 3957. Such structural log members shall be identified by the grade mark of an approved lumber grading or inspection agency. In lieu of a grade mark on the material, a certificate of inspection as to species and grade issued by a lumber grading or inspection agency meeting the requirements of this section shall be permitted.

2303.1.11 Round timber poles and piles. Round timber poles and piles shall comply with ASTM D 3200 and ASTM D 25, respectively

2303.2 Fire-retardant-treated wood. Fire-retardant-treated wood is any wood product which, when impregnated with chemicals by a pressure process or other means during manufacture, shall have, when tested in accordance with ASTM E 84, a listed flame spread index of 25 or less and show no evidence of significant progressive combustion when the test is continued for an additional 20-minute period. In addition, the flame front shall not progress more than 10.5 feet (3200 mm) beyond the centerline of the burners at any time during the test.

2303.2.1 Labeling. Fire-retardant-treated lumber and wood structural panels shall be labeled. The label shall contain the following items:

1. The identification mark of an approved agency in accordance with Section 1703.5.
2. Identification of the treating manufacturer.
3. The name of the fire-retardant treatment.
4. The species of wood treated.
5. Flame spread and smoke-developed index.
6. Method of drying after treatment.
7. Conformance with appropriate standards in accordance with Sections 2303.2.2 through 2303.2.5.
8. For fire-retardant-treated wood exposed to weather, damp or wet locations, include the words "No increase in the listed classification when subjected to the Standard Rain Test" (ASTM D 2898).

2303.2.2 Strength adjustments. Design values for untreated lumber and wood structural panels, as specified in Section 2303.1, shall be adjusted for fire-retardant-treated wood. Adjustments to design values shall be based on an approved method of investigation that takes into consideration the effects of the anticipated temperature and humidity to which the fire-retardant-treated wood will be subjected, the type of treatment and redrying procedures.

2303.2.2.1 Wood structural panels. The effect of treatment and the method of redrying after treatment, and exposure to high temperatures and high humidities on the flexure properties of fire-retardant-treated softwood plywood shall be determined in accordance with ASTM D 5516. The test data developed by ASTM D 5516 shall be used to develop adjustment factors, maximum loads and spans, or both, for untreated plywood design values in accordance with ASTM D 6305. Each manufacturer shall publish the allowable maximum loads and spans for service as floor and roof sheathing for its treatment.

2303.2.2.2 Lumber. For each species of wood that is treated, the effects of the treatment, the method of redrying after treatment and exposure to high temperatures and high humidities on the allowable design properties of fire-retardant-treated lumber shall be determined in accordance with ASTM D 5664. The test data developed by ASTM D 5664 shall be used to develop modification factors for use at or near room temperature and at elevated temperatures and humidity in accordance with ASTM D 6841. Each manufacturer shall publish the modification factors for service at temperatures of not less than 80°F (27°C) and for roof framing. The roof framing modification factors shall take into consideration the climatological location.

2303.2.3 Exposure to weather, damp or wet locations. Where fire-retardant-treated wood is exposed to weather, or damp or wet locations, it shall be identified as "Exterior" to indicate there is no increase in the listed flame spread index as defined in Section 2303.2 when subjected to ASTM D 2898.

2303.2.4 Interior applications. Interior fire-retardant-treated wood shall have moisture content of not over 28 percent when tested in accordance with ASTM D 3201 procedures at 92-percent relative humidity. Interior fire-retardant-treated wood shall be tested in accordance with Section 2303.2.2.1 or 2303.2.2.2. Interior fire-retardant-treated wood designated as Type A shall be tested in accordance with the provisions of this section.

2303.2.5 Moisture content. Fire-retardant-treated wood shall be dried to a moisture content of 19 percent or less for lumber and 15 percent or less for wood structural panels before use. For wood kiln dried after treatment (KDAT), the kiln temperatures shall not exceed those used in kiln drying the lumber and plywood submitted for the tests described in Section 2303.2.2.1 for plywood and 2303.2.2.2 for lumber.

2303.2.6 Type I and II construction applications. See Section 603.1 for limitations on the use of fire-retardant-treated wood in buildings of Type I or II construction.

2303.3 Hardwood and plywood. Hardwood and decorative plywood shall be manufactured and identified as required in HPVA HP-1.

2303.4 Trusses.

2303.4.1 Design. Wood trusses shall be designed in accordance with the provisions of this code and accepted engineering practice. Members are permitted to be joined by nails, glue, bolts, timber connectors, metal connector plates or other approved framing devices.

2303.4.1.1 Truss designer. The individual or organization responsible for the design of trusses.

2303.4.1.2 Truss design drawings. The written, graphic and pictorial **depiction** of each individual truss shall be provided to the building official and approved prior to installation. Truss design drawings shall also be provided with the shipment of trusses delivered to the job site. Truss design drawings shall include, at a minimum, the information specified below:

1. Slope or depth, span and spacing;
2. Location of joints;
3. Required bearing widths;
4. Design loads as applicable;
5. Top chord live load;
6. Top chord dead load;
7. Bottom chord live load;
8. Bottom chord dead load;
9. Concentrated loads and their points of application as applicable;
10. Controlling wind loads as applicable;
11. Adjustments to lumber and metal connector plate design value for conditions of use;
12. Each reaction force and direction;
13. Metal connector plate type, size, thickness or gage, and the dimensioned location of each metal connector plate except where symmetrically located relative to the joint interface;

14. Lumber size, species and grade for each member;
15. Connection requirements for:
    15.1. Truss to truss;
    15.2. Truss ply to ply; and
    15.3. Field splices.
16. Calculated deflection ratio and maximum vertical and horizontal deflection for live and total load as applicable;
17. Maximum axial tension and compression forces in the truss members; and
18. Required permanent individual truss member bracing and method per Section 2303.4.1.5, unless a specific truss member permanent bracing plan for the roof or floor structural system is provided by a registered design professional.

Where required by one of the following, each individual truss design drawing shall bear the seal and signature of the truss designer:

1. Registered design professional; or
2. Building official; or
3. Statutes of the jurisdiction in which the project is to be constructed.

Exceptions:

1. When a cover sheet/truss index sheet combined into a single cover sheet is attached to the set of truss design drawings for the project, the single sheet/truss index sheet is the only document that needs to be signed and sealed within the truss submittal package.
2. When a cover sheet and a truss index sheet are separately provided and attached to the set of truss design drawings for the project, both the cover sheet and the truss index sheet are the only documents that need to be signed and sealed within the truss submittal package.

2303.4.1.3 Truss placement diagram. The truss manufacturer shall provide a truss placement diagram that identifies the proposed location for each individually designated truss and references the corresponding truss design drawing. The truss placement diagram shall be provided as part of the truss submittal package, and with the shipment of trusses delivered to the job site. Truss placement diagrams shall not be required to bear the seal or signature of the truss designer.

Exception: When the truss placement diagram is prepared under the direct supervision of a registered design professional, it is required to be signed and sealed.

2303.4.1.4 Truss submittal package. The truss submittal package shall consist of each individual truss design drawing, the truss placement diagram for the project, the truss member permanent bracing specification and, as applicable, the cover sheet/truss index sheet.

2303.4.1.5 Truss member permanent bracing. Where permanent bracing of truss members is required on the truss design drawings, it shall be accomplished by one of the following methods:

1. The trusses shall be designed so that the buckling of any individual truss member can be resisted internally by the structure (e.g. buckling member T-bracing, L-bracing, etc.) of the individual truss. The truss individual member buckling reinforcement shall be installed as shown on the truss design drawing or on supplemental truss member buckling reinforcement diagrams provided by the truss designer.
2. Permanent bracing shall be installed using standard industry bracing details that conform with generally accepted engineering practice. Individual truss member continuous lateral bracing location(s) shall be shown on the truss design drawing.

2303.4.1.6 Anchorage. All transfer of loads and anchorage of each truss to the supporting structure is the responsibility of the registered design professional.

2303.4.1.7 Alterations to trusses. Truss members and components shall not be cut, notched, drilled, spliced or otherwise altered in any way without written concurrence and approval of a registered design professional. Alterations resulting in the addition of loads to any member (e.g., HVAC equipment, water heater) shall not be permitted without verification that the truss is capable of supporting such additional loading.

2303.4.2 Metal-plate-connected trusses. In addition to Sections 2303.4.1 through 2303.4.1.7, the design, manufacture and quality assurance of metal-plate-connected wood trusses shall be in accordance with TPI 1. Manufactured trusses shall comply with Section 1704.6 as applicable.

2303.5 Test standard for joist hangers and connectors. For the required test standards for joist hangers and connectors, see Section 1715.1.

2303.6 Nails and staples. Nails and staples shall conform to requirements of ASTM F 1667. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as follows: 80 kips per square inch (ksi) (551 MPa) for shank diameters larger than 0.177 inch (4.50 mm) but not larger than 0.254 inch (6.45 mm), 90 ksi (620 MPa) for shank diameters larger than 0.142 inch (3.61 mm) but not larger than 0.177 inch (4.50 mm) and 100 ksi (689 MPa) for shank diameters of at least 0.099 inch (2.51 mm) but not larger than 0.142 inch (3.61 mm).

2303.7 Shrinkage. Consideration shall be given in design to the possible effect of cross-grain dimensional changes considered vertically which may occur in lumber fabricated in a green condition.

SECTION 2304
GENERAL CONSTRUCTION REQUIREMENTS

2304.1 General. The provisions of this section apply to design methods specified in Section 2301.2.

2304.2 Size of structural members. Computations to determine the required sizes of members shall be based on the net dimensions (actual sizes) and not nominal sizes.

2304.3 Wall framing. The framing of exterior and interior walls shall be in accordance with the provisions specified in Section 2308 unless a specific design is furnished.

2304.3.1 Bottom plates. Studs shall have full bearing on a 2-inch-thick (actual $1^1/_2$-inch, 38 mm) or larger plate or sill having a width at least equal to the width of the studs.

2304.3.2 Framing over openings. Headers, double joists, trusses or other approved assemblies that are of adequate size to transfer loads to the vertical members shall be provided over window and door openings in load-bearing walls and partitions.

2304.3.3 Shrinkage. Wood walls and bearing partitions shall not support more than two floors and a roof unless an analysis satisfactory to the building official shows that shrinkage of the wood framing will not have adverse effects on the structure or any plumbing, electrical or mechanical systems, or other equipment installed therein due to excessive shrinkage or differential movements caused by shrinkage. The analysis shall also show that the roof drainage system and the foregoing systems or equipment will not be adversely affected or, as an alternate, such systems shall be designed to accommodate the differential shrinkage or movements.

2304.3.4 Gable endwalls.

2304.3.4.1 General. Gable endwalls shall be structurally continuous between points of lateral support.

2304.3.4.2 Cathedral endwalls. Gable endwalls adjacent to cathedral ceilings shall be structurally continuous from the uppermost floor to the ceiling diaphragm or to the roof diaphragm.

2304.3.4.3 Full height studs. Full height studs may be sized using the bracing at a ceiling diaphragm for determining stud length requirements.

2304.4 Floor and roof framing. The framing of wood-joisted floors and wood framed roofs shall be in accordance with the provisions specified in Section 2308 unless a specific design is furnished.

2304.5 Framing around flues and chimneys. Combustible framing shall be a minimum of 2 inches (51 mm), but shall not be less than the distance specified in Sections 2111 and 2113 and the *Florida Building Code, Mechanical*, from flues, chimneys and fireplaces, and 6 inches (152 mm) away from flue openings.

2304.6 Wall sheathing. Except as provided for in Section 1405 for weatherboarding or where stucco construction that complies with Section 2510 is installed, enclosed buildings shall be sheathed with one of the materials of the nominal thickness specified in Table 2304.6 or any other approved material of equivalent strength or durability.

2304.6.1 Wood structural panel sheathing. Where wood structural panel sheathing is used as the exposed finish on the exterior of outside walls, it shall have an exterior exposure durability classification. Where wood structural panel sheathing is used on the exterior of outside walls but not as the exposed finish, it shall be of a type manufactured with exterior glue (Exposure 1 or Exterior). Where wood structural panel sheathing is used elsewhere, it shall be of a type manufactured with intermediate or exterior glue.

2304.6.2 Interior paneling. Softwood wood structural panels used for interior paneling shall conform with the provisions of Chapter 8 and shall be installed in accordance with Table 2304.9.1. Panels shall comply with DOC PS 1 or PS 2. Prefinished hardboard paneling shall meet the requirements of AHA A135.5. Hardwood plywood shall conform to HPVA HP-1.

2304.7 Floor and roof sheathing.

2304.7.1 Structural floor sheathing. Structural floor sheathing shall be designed in accordance with the general provisions of this code and the special provisions in this section.

Floor sheathing conforming to the provisions of Table 2304.7(1), 2304.7(2), 2304.7(3) or 2304.7(4) shall be deemed to meet the requirements of this section.

2304.7.2 Structural roof sheathing. Structural roof sheathing shall be designed in accordance with the general provisions of this code and the special provisions in this section.

Roof sheathing conforming to the provisions of Table 2304.7(1), 2304.7(2), 2304.7(3) or 2304.7(5) shall be

TABLE 2304.6
MINIMUM THICKNESS OF WALL SHEATHING

SHEATHING TYPE	MINIMUM THICKNESS	MAXIMUM WALL STUD SPACING
Wood boards	$^5/_8$ inch	24 inches on center
Fiberboard	$^1/_2$ inch	16 inches on center
Wood structural panel	In accordance with Tables 2308.9.3(2) and 2308.9.3(3)	—
M-S "Exterior Glue" and M-2 "Exterior Glue" Particleboard	In accordance with Tables 2306.4.3 and 2308.9.3(4)	—
Gypsum sheathing	$^1/_2$ inch	16 inches on center
Gypsum wallboard	$^1/_2$ inch	24 inches on center
Reinforced cement mortar	1 inch	24 inches on center

For SI: 1 inch = 25.4 mm.

deemed to meet the requirements of this section. Wood structural panel roof sheathing shall be bonded by exterior glue.

2304.8 Lumber decking.

2304.8.1 General. Lumber decking shall be designed and installed in accordance with the general provisions of this code and the provisions of this section. Each piece shall be square-end trimmed. When random lengths are furnished, each piece shall be square-end trimmed across the face so that at least 90 percent of the pieces will be within 0.5 degrees (0.00873 rad) of square. The ends of the pieces shall be permitted to be beveled up to 2 degrees (0.0349 rad) from vertical with the exposed face of the piece slightly longer than the back of the piece. Tongue-and-groove decking shall be installed with the tongues up on sloped or pitched roofs with pattern faces down.

2304.8.2 Layup patterns. Lumber decking is permitted to be laid up following one of five standard patterns as defined in Sections 2304.8.2.1 through 2304.8.2.5. Other patterns are permitted to be used if justified by engineering analysis.

2304.8.2.1 Simple span pattern. All pieces shall be supported by two supports.

2304.8.2.2 Two-span continuous pattern. All pieces shall be supported by three supports, and all end joints shall occur in line on every other support. Supporting members shall be designed to accommodate the load redistribution caused by this pattern.

2304.8.2.3 Combination simple and two-span continuous pattern. Courses in end spans shall be alternating simple span and two span continuous. End joints are staggered in adjacent courses and occur only over supports.

2304.8.2.4 Cantilevered pieces intermixed pattern. The decking shall cover a minimum of three spans. Pieces in the starter course and every third course shall be simple span. Pieces in other courses shall be cantilevered over the supports with end joints at alternate quarter or third points of the spans, and each piece shall bear on at least one support.

2304.8.2.5 Controlled random pattern. The decking shall cover a minimum of three spans. End joints within 6 inches (152 mm) of being in line in either direction shall be separated by at least two intervening courses. In the end bays each piece shall bear on at least one support. Where an end joint occurs in an end bay, the next piece in the same course shall continue over the first inner support for at least 24 inches (610 mm). The details of the controlled random pattern shall be as described for each decking material in Section 2304.8.3.3, 2304.8.4.3 or 2304.8.5.3.

For cantilevered spans with the controlled random pattern, special considerations shall be made when the overhang exceeds 18 inches (457 mm), 24 inches (610 mm) or 36 inches (914 mm) for 2-inch (51 mm), 3-inch (76 mm) or 4-inch (102 mm) nominal thickness decking, respectively. The maximum cantilevered length for the controlled random pattern shall be 30 percent of the length of the first adjacent interior span. For cantilever overhangs within these limits, a structural fascia shall be fastened to each decking piece to maintain a continuous, straight roof line. There shall be no end joints in the can-

TABLE 2304.7(1)
ALLOWABLE SPANS FOR LUMBER FLOOR AND ROOF SHEATHING[a,b]

SPAN (inches)	MINIMUM NET THICKNESS (inches) OF LUMBER PLACED			
	Perpendicular to supports		Diagonally to supports	
	Surfaced dry[c]	Surfaced unseasoned	Surfaced dry[c]	Surfaced unseasoned
Floors				
24	$^3/_4$	$^{25}/_{32}$	$^3/_4$	$^{25}/_{32}$
16	$^5/_8$	$^{11}/_{16}$	$^5/_8$	$^{11}/_{16}$
Roofs				
24	$^5/_8$	$^{11}/_{16}$	$^3/_4$	$^{25}/_{32}$

For SI: 1 inch = 25.4 mm.
a. Installation details shall conform to Sections 2304.7.1 and 2304.7.2 for floor and roof sheathing, respectively.
b. Floor or roof sheathing conforming with this table shall be deemed to meet the design criteria of Section 2304.7.
c. Maximum 19-percent moisture content.

TABLE 2304.7(2)
SHEATHING LUMBER, MINIMUM GRADE REQUIREMENTS: BOARD GRADE

SOLID FLOOR OR ROOF SHEATHING	SPACED ROOF SHEATHING	GRADING RULES
Utility	Standard	NLGA, WCLIB, WWPA
4 common or utility	3 common or standard	NLGA, WCLIB, WWPA, NSLB or NELMA
No. 3	No. 2	SPIB
Merchantable	Construction common	RIS

TABLE 2304.7(3)
ALLOWABLE SPANS AND LOADS FOR WOOD STRUCTURAL PANEL SHEATHING AND SINGLE-FLOOR GRADES CONTINUOUS OVER TWO OR MORE SPANS WITH STRENGTH AXIS PERPENDICULAR TO SUPPORTS[a,b]

SHEATHING GRADES		ROOF[c]				FLOOR[d]
		Maximum span (inches)		Load[e] (psf)		
Panel span rating roof/floor span	Panel thickness (inches)	With edge support[f]	Without edge support	Total load	Live load	Maximum span (inches)
12/0	5/16	12	12	40	30	0
16/0	5/16, 3/8	16	16	40	30	0
20/0	5/16, 3/8	20	20	40	30	0
24/0	3/8, 7/16, 1/2	24	20[g]	40	30	0
24/16	7/16, 1/2	24	24	50	40	16
32/16	15/32, 1/2, 5/8	32	28	40	30	16[h]
40/20	19/32, 5/8, 3/4, 7/8	40	32	40	30	20[h,i]
48/24	23/32, 3/4, 7/8	48	36	45	35	24
54/32	7/8, 1	54	40	45	35	32
60/32	7/8, 1 1/8	60	48	45	35	32
SINGLE FLOOR GRADES		**ROOF[c]**				**FLOOR[d]**
		Maximum span (inches)		**Load[e] (psf)**		
Panel span rating	**Panel thickness (inches)**	**With edge support[f]**	**Without edge support**	**Total load**	**Live load**	**Maximum span (inches)**
16 o.c.	1/2, 19/32, 5/8	24	24	50	40	16[h]
20 o.c.	19/32, 5/8, 3/4	32	32	40	30	20[h,i]
24 o.c.	23/32, 3/4	48	36	35	25	24
32 o.c.	7/8, 1	48	40	50	40	32
48 o.c.	1 3/32, 1 1/8	60	48	50	40	48

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m^2.

a. Applies to panels 24 inches or wider.
b. Floor and roof sheathing conforming with this table shall be deemed to meet the design criteria of Section 2304.7.
c. Uniform load deflection limitations 1/180 of span under live load plus dead load, 1/240 under live load only.
d. Panel edges shall have approved tongue-and-groove joints or shall be supported with blocking unless 1/4-inch minimum thickness underlayment or 1 1/2 inches of approved cellular or lightweight concrete is placed over the subfloor, or finish floor is 3/4-inch wood strip. Allowable uniform load based on deflection of 1/360 of span is 100 pounds per square foot except the span rating of 48 inches on center is based on a total load of 65 pounds per square foot.
e. Allowable load at maximum span.
f. Tongue-and-groove edges, panel edge clips (one midway between each support, except two equally spaced between supports 48 inches on center), lumber blocking or other. Only lumber blocking shall satisfy blocked diaphragm requirements.
g. For 1/2-inch panel, maximum span shall be 24 inches.
h. Span is permitted to be 24 inches on center where 3/4-inch wood strip flooring is installed at right angles to joist.
i. Span is permitted to be 24 inches on center for floors where 1 1/2 inches of cellular or lightweight concrete is applied over the panels.

tilevered portion or within one-half of the first adjacent interior span.

2304.8.3 Mechanically laminated decking.

2304.8.3.1 General. Mechanically laminated decking consists of square-edged dimension lumber laminations set on edge and nailed to the adjacent pieces and to the supports.

2304.8.3.2 Nailing. The length of nails connecting laminations shall not be less than two and one-half times the net thickness of each lamination. Where deck supports are 48 inches (1219 mm) on center (o.c.) or less, side nails shall be spaced not more than 30 inches (762 mm) o.c. alternately near top and bottom edges, and staggered one-third of the spacing in adjacent laminations. Where supports are spaced more than 48 inches (1219 mm) o.c., side nails shall be spaced not more than 18 inches (457 mm) o.c. alternately near top and bottom edges and staggered one-third of the spacing in adjacent laminations. Two side nails shall be used at each end of butt-jointed pieces.

Laminations shall be toenailed to supports with 20d or larger common nails. Where the supports are 48 inches (1219 mm) o.c. or less, alternate laminations shall be toenailed to alternate supports; where supports are spaced more than 48 inches (1219 mm) o.c., alternate laminations shall be toenailed to every support.

2304.8.3.3 Controlled random pattern. There shall be a minimum distance of 24 inches (610 mm) between end

TABLE 2304.7(4)
ALLOWABLE SPAN FOR WOOD STRUCTURAL PANEL COMBINATION SUBFLOOR-UNDERLAYMENT (SINGLE FLOOR)[a,b]
(Panels Continuous Over Two or More Spans and Strength Axis Perpendicular to Supports)

IDENTIFICATION	MAXIMUM SPACING OF JOISTS (inches)				
	16	20	24	32	48
Species group[c]	Thickness (inches)				
1	$^1/_2$	$^5/_8$	$^3/_4$	—	—
2, 3	$^5/_8$	$^3/_4$	$^7/_8$	—	—
4	$^3/_4$	$^7/_8$	1	—	—
Single floor span rating[d]	16 o.c.	20 o.c.	24 o.c.	32 o.c.	48 o.c.

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m^2.

a. Spans limited to value shown because of possible effects of concentrated loads. Allowable uniform loads based on deflection of $^1/_{360}$ of span is 100 pounds per square foot except allowable total uniform load for 1$^1/_8$-inch wood structural panels over joists spaced 48 inches on center is 65 pounds per square foot. Panel edges shall have approved tongue-and-groove joints or shall be supported with blocking, unless $^1/_4$-inch minimum thickness underlayment or 1 $^1/_2$ inches of approved cellular or lightweight concrete is placed over the subfloor, or finish floor is $^3/_4$-inch wood strip.

b. Floor panels conforming with this table shall be deemed to meet the design criteria of Section 2304.7.

c. Applicable to all grades of sanded exterior-type plywood. See DOC PS 1 for plywood species groups.

d. Applicable to Underlayment grade, C-C (Plugged) plywood, and Single Floor grade wood structural panels.

TABLE 2304.7(5)
ALLOWABLE LOAD (PSF) FOR WOOD STRUCTURAL PANEL ROOF SHEATHING CONTINUOUS OVER TWO OR MORE SPANS AND STRENGTH AXIS PARALLEL TO SUPPORTS
(Plywood Structural Panels Are Five-Ply, Five-Layer Unless Otherwise Noted)[a,b]

PANEL GRADE	THICKNESS (inch)	MAXIMUM SPAN (inches)	LOAD AT MAXIMUM SPAN (psf)	
			Live	Total
Structural I sheathing	$^7/_{16}$	24	20	30
	$^{15}/_{32}$	24	35[c]	45[c]
	$^1/_2$	24	40[c]	50[c]
	$^{19}/_{32}$, $^5/_8$	24	70	80
	$^{23}/_{32}$, $^3/_4$	24	90	100
Sheathing, other grades covered in DOC PS 1 or DOC PS 2	$^7/_{16}$	16	40	50
	$^{15}/_{32}$	24	20	25
	$^1/_2$	24	25	30
	$^{19}/_{32}$	24	40[c]	50[c]
	$^5/_8$	24	45[c]	55[c]
	$^{23}/_{32}$, $^3/_4$	24	60[c]	65[c]

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m^2.

a. Roof sheathing conforming with this table shall be deemed to meet the design criteria of Section 2304.7.

b. Uniform load deflection limitations $^1/_{180}$ of span under live load plus dead load, $^1/_{240}$ under live load only. Edges shall be blocked with lumber or other approved type of edge supports.

c. For composite and four-ply plywood structural panel, load shall be reduced by 15 pounds per square foot.

joints in adjacent courses. The pieces in the first and second courses shall bear on at least two supports with end joints in these two courses occurring on alternate supports. A maximum of seven intervening courses shall be permitted before this pattern is repeated.

2304.8.4 Two-inch sawn tongue-and-groove decking.

2304.8.4.1 General. Two-inch (51 mm) decking shall have a maximum moisture content of 15 percent. Decking shall be machined with a single tongue-and-groove pattern. Each deck piece shall be nailed to each support as required.

2304.8.4.2 Nailing. Each piece of decking shall be toenailed at each support with one 16d common nail through the tongue and face-nailed with one 16d common nail.

2304.8.4.3 Controlled random pattern. There shall be a minimum distance of 24 inches (610 mm) between end joints in adjacent courses. The pieces in the first and second courses shall bear on at least two supports with end joints in these two courses occurring on alternate supports. A maximum of seven intervening courses shall be permitted before this pattern is repeated.

2304.8.5 Three- and 4-inch sawn tongue-and-groove decking.

2304.8.5.1 General. Three-inch (76 mm) and 4-inch (102 mm) decking shall have a maximum moisture content of 19 percent. Decking shall be machined with a double tongue-and-groove pattern. Deck pieces shall be interconnected and fastened to the supports as required.

2304.8.5.2 Nailing. Each piece shall be toenailed at each support with one 40d common nail and face-nailed with one 60d common nail. Courses shall be spiked to each other with 8-inch (203 mm) spikes at intervals not to exceed 30 inches (762 mm) through predrilled edge holes penetrating to a depth of approximately 4 inches (102 mm) and with one spike at a distance not exceeding 10 inches (254 mm) from the end of each piece.

2304.8.5.3 Controlled random pattern. There shall be a minimum distance of 48 inches (1219 mm) between end joints in adjacent courses. Pieces not bearing over a support are permitted to occur in interior bays, provided the adjacent pieces in the same course continue over the support for at least 24 inches (610 mm). This condition shall not occur more than once in every six courses in each interior bay.

2304.9 Connections and fasteners.

2304.9.1 Fastener requirements. Connections for wood members shall be designed in accordance with the appropriate methodology in Section 2301.2. The number and size of fasteners connecting wood members shall not be less than that set forth in Table 2304.9.1.

2304.9.2 Sheathing fasteners. Sheathing nails or other approved sheathing connectors shall be driven so that their head or crown is flush with the surface of the sheathing.

2304.9.3 Joist hangers and framing anchors. Connections depending on joist hangers or framing anchors, ties and other mechanical fastenings not otherwise covered are permitted where approved. The vertical load-bearing capacity, torsional moment capacity and deflection characteristics of joist hangers shall be determined in accordance with Section 1715.1.

2304.9.4 Other fasteners. Clips, staples, glues and other approved methods of fastening are permitted where approved.

2304.9.5 Fasteners in preservative-treated and fire-retardant-treated wood. Fasteners for preservative-treated and fire-retardant-treated wood shall be in accordance with Section 2304.9.5.1 through 2304.9.5.4.

2304.9.5.1 Fasteners for preservative-treated wood. Fasteners for preservative-treated wood shall be of hot-dipped zinc-coated galvanized steel, stainless steel, silicon bronze or copper. The coating weights for zinc-coated fasteners shall be in accordance with ASTM A 153.

Exception: Fasteners other than nails and timber rivets shall be permitted to be of mechanically deposited zinc-coated steel with coating weights in accordance with ASTM B 695, Class 55 minimum.

2304.9.5.2 Fastenings for wood foundations. Fastenings for wood foundations shall be as required in AF&PA Technical Report No. 7.

2304.9.5.3 Fasteners for fire-retardant-treated wood used in exterior applications or wet or damp locations. Fasteners for fire-retardant-treated wood used in exterior applications or wet or damp locations shall be of hot-dipped zinc-coated galvanized steel, stainless steel, silicon bronze or copper. Fasteners other than nails, timber rivets, wood screws and lag screws shall be permitted to be of mechanically deposited zinc-coated steel with coating weights in accordance with ASTM B 695, Class 55 minimum.

2304.9.5.4 Fasteners for fire-retardant-treated wood used in interior applications. Fasteners for fire-retardant-treated wood used in interior locations shall be in accordance with the manufacturer's recommendations. In the absence of manufacturer's recommendations Section 2304.9.5.3 shall apply.

2304.9.6 Load path. Where wall framing members are not continuous from foundation sill to roof, the members shall be secured to ensure a continuous load path. Where required, sheet metal clamps, ties or clips shall be formed of galvanized steel or other approved corrosion-resistant material not less than 0.040 inch (1.01 mm) nominal thickness.

2304.9.7 Framing requirements. Wood columns and posts shall be framed to provide full end bearing. Alternatively, column-and-post end connections shall be designed to resist the full compressive loads, neglecting end-bearing capacity. Column-and-post end connections shall be fastened to resist lateral and net induced uplift forces.

2304.10 Heavy timber construction.

TABLE 2304.9.1
FASTENING SCHEDULE

CONNECTION	FASTENING[a,m]	LOCATION
1. Joist to sill or girder	3 - 8d common ($2^1/_2$″ × 0.131″) 3 - 3″ × 0.131″ nails 3 - 3″ 14 gage staples	toenail
2. Bridging to joist	2 - 8d common ($2^1/_2$″ × 0.131″) 2 - 3″ × 0.131″ nails 2 - 3″ 14 gage staples	toenail each end
3. 1″ × 6″ subfloor or less to each joist	2 - 8d common ($2^1/_2$″ × 0.131″)	face nail
4. Wider than 1″ × 6″ subfloor to each joist	3 - 8d common ($2^1/_2$″ × 0.131″)	face nail
5. 2″ subfloor to joist or girder	2 - 16d common ($3^1/_2$″ × 0.162″)	blind and face nail
6. Sole plate to joist or blocking	16d ($3^1/_2$″ × 0.135″) at 16″ o.c. 3″ × 0.131″ nails at 8″ o.c. 3″ 14 gage staples at 12″ o.c.	typical face nail
Sole plate to joist or blocking at braced wall panel	3″ - 16d ($3^1/_2$″ × 0.135″) at 16″ 4 - 3″ × 0.131″ nails at 16″ 4 - 3″ 14 gage staples per 16″	braced wall panels
7. Top plate to stud	2 - 16d common ($3^1/_2$″ × 0.162″) 3 - 3″ × 0.131″ nails 3 - 3″ 14 gage staples	end nail
8. Stud to sole plate	4 - 8d common ($2^1/_2$″ × 0.131″) 4 - 3″ × 0.131″ nails 3 - 3″ 14 gage staples	toenail
	2 - 16d common ($3^1/_2$″ × 0.162″) 3 - 3″ × 0.131″ nails 3 - 3″ 14 gage staples	end nail
9. Double studs	16d ($3^1/_2$″ × 0.135″) at 24″ o.c. 3″ × 0.131″ nail at 8″ o.c. 3″ 14 gage staple at 8″ o.c.	face nail
10. Double top plates	16d ($3^1/_2$″ × 0.135″) at 16″ o.c. 3″ × 0.131″ nail at 12″ o.c. 3″ 14 gage staple at 12″ o.c.	typical face nail
Double top plates	8-16d common ($3^1/_2$″ × 0.162″) 12-3″ × 0.131″ nails 12-3″ 14 gage staples	lap splice
11. Blocking between joists or rafters to top plate	3 - 8d common ($2^1/_2$″ × 0.131″) 3 - 3″ × 0.131″ nails 3 - 3″ 14 gage staples	toenail
12. Rim joist to top plate	8d ($2^1/_2$″ × 0.131″) at 6″ o.c. 3″ × 0.131″ nail at 6″ o.c. 3″ 14 gage staple at 6″ o.c.	toenail
13. Top plates, laps and intersections	2 - 16d common ($3^1/_2$″ × 0.162″) 3 - 3″ × 0.131″ nails 3 -3″ 14 gage staples	face nail
14. Continuous header, two pieces	16d common ($3^1/_2$″ × 0.162″)	16″ o.c. along edge
15. Ceiling joists to plate	3 - 8d common ($2^1/_2$″ × 0.131″) 5 - 3″ × 0.131″ nails 5 - 3″ 14 gage staples	toenail
16. Continuous header to stud	4 - 8d common ($2^1/_2$″ × 0.131″)	toenail

(continued)

TABLE 2304.9.1—continued
FASTENING SCHEDULE

CONNECTION	FASTENING[a,m]	LOCATION
17. Ceiling joists, laps over partitions (see Section 2308.10.4.1, Table 2308.10.4.1)	3 - 16d common ($3^1/_2$″ × 0.162″) minimum, Table 2308.10.4.1 4 - 3″ × 0.131″ nails 4 - 3″ 14 gage staples	face nail
18. Ceiling joists to parallel rafters (see Section 2308.10.4.1, Table 2308.10.4.1)	3 - 16d common ($3^1/_2$″ × 0.162″) minimum, Table 2308.10.4.1 4 - 3″ × 0.131″ nails 4 - 3″ 14 gage staples	face nail
19. Rafter to plate (see Section 2308.10.1, Table 2308.10.1)	3 - 8d common ($2^1/_2$″ × 0.131″) 3 - 3″ × 0.131″ nails 3 - 3″ 14 gage staples	toenail
20. 1″ diagonal brace to each stud and plate	2 - 8d common ($2^1/_2$″ × 0.131″) 2 - 3″ × 0.131″ nails 3 - 3″ 14 gage staples	face nail
21. 1″ × 8″ sheathing to each bearing	3 - 8d common ($2^1/_2$″ × 0.131″)	face nail
22. Wider than 1″ × 8″ sheathing to each bearing	3 - 8d common ($2^1/_2$″ × 0.131″)	face nail
23. Built-up corner studs	16d common ($3^1/_2$″ × 0.162″) 3″ × 0.131″ nails 3″ 14 gage staples	24″ o.c. 16″ o.c. 16″ o.c.
24. Built-up girder and beams	20d common (4″ × 0.192″) 32″ o.c. 3″ × 0.131″ nail at 24″ o.c. 3″ 14 gage staple at 24″ o.c.	face nail at top and bottom staggered on opposite sides
	2 - 20d common (4″ × 0.192″) 3 - 3″ × 0.131″ nails 3 - 3″ 14 gage staples	face nail at ends and at each splice
25. 2″ planks	16d common ($3^1/_2$″ × 0.162″)	at each bearing
26. Collar tie to rafter	3 - 10d common (3″ × 0.148″) 4 - 3″ x 0.131″ nails 4 - 3″ 14 gage staples	face nail
27. Jack rafter to hip	3 - 10d common (3″ x 0.148″) 4 - 3″ × 0.131″ nails 4 - 3″ 14 gage staples	toenail
	2 - 16d common ($3^1/_2$″ × 0.162″) 3 -3″ × 0.131″ nails 3 - 3″ 14 gage staples	face nail
28. Roof rafter to 2-by ridge beam	2 - 16d common ($3^1/_2$″ × 0.162″) 3 - 3″ × 0.131″ nails 3 - 3″ 14 gage staples	toenail
	2-16d common ($3^1/_2$″ × 0.162″) 3 - 3″ × 0.131″ nails 3 - 3″ 14 gage staples	face nail
29. Joist to band joist	3 - 16d common ($3^1/_2$″ × 0.162″) 4 - 3″ × 0.131″ nails 4 - 3″ 14 gage staples	face nail

(continued)

TABLE 2304.9.1—continued
FASTENING SCHEDULE

CONNECTION	FASTENING[a,m]		LOCATION
30. Ledger strip	3 - 16d common ($3^1/_2'' \times 0.162''$) 4 - $3'' \times 0.131''$ nails 4 - $3''$ 14 gage staples		face nail
31. Wood structural panels and particleboard[b] Subfloor, roof and wall sheathing (to framing)	$^1/_2''$ and less	6d[c,l] $2\ ^3/_8'' \times 0.113''$ nail[n] $1\ ^3/_4''$ 16 gage[o]	
	$^{15}/_{32}''$ in to $^{19}/_{32}''$	8d common (roofs in 110-140 mph (Exp. B)	6 inch o.c. edges and intermediate, 4 inch o.c. at component and cladding edge strip #3 [refer to Figure 6-3 of ASCE 7]
	$^{19}/_{32}''$ to $^3/_4''$	8d[d] or 6d[e] $2\ ^3/_8'' \times 0.113''$ nail[p] $2''$ 16 gage[p]	
	$^7/_8''$ to $1''$	8d[c]	
	$1\ ^1/_8''$ to $1\ ^1/_4''$	10d[d] or 8d[d]	
Single Floor (combination subfloor-underlayment to framing)	$^3/_4''$ and less	6d[e]	
	$^7/_8''$ to $1''$	8d[e]	
	$1\ ^1/_8''$ to $1\ ^1/_4''$	10d[d] or 8d[e]	
32. Panel siding (to framing)	$^1/_2''$ or less $^5/_8''$	6d[f] 8d[f]	
33. Fiberboard sheathing[g]	$^1/_2''$	No. 11 gage roofing nail[h] 6d common nail ($2'' \times 0.113''$) No. 16 gage staple[i]	
	$^{25}/_{32}''$	No. 11 gage roofing nail[h] 8d common nail ($2^1/_2'' \times 0.131''$) No. 16 gage staple[i]	
34. Interior paneling	$^1/_4''$ $^3/_8''$	4d[j] 6d[k]	

For SI: 1 inch = 25.4 mm.

a. Common or box nails are permitted to be used except where otherwise stated.

b. Nails spaced at 6 inches on center at edges, 12 inches at intermediate supports except 6 inches at supports where spans are 48 inches or more. For nailing of wood structural panel and particleboard diaphragms and shear walls, refer to Section 2305. Nails for wall sheathing are permitted to be common, box or casing.

c. Common or deformed shank (6d - $2'' \times 0.113''$; 8d - $2^1/_2'' \times 0.131''$; 10d - $3'' \times 0.148''$).

d. Common (6d - $2'' \times 0.113''$; 8d - $2^1/_2'' \times 0.131''$; 10d - $3'' \times 0.148''$).

e. Deformed shank (6d - $2'' \times 0.113''$; 8d - $2^1/_2'' \times 0.131''$; 10d - $3'' \times 0.148''$).

f. Corrosion-resistant siding (6d - $1^7/_8'' \times 0.106''$; 8d - $2^3/_8'' \times 0.128''$) or casing (6d - $2'' \times 0.099''$; 8d - $2^1/_2'' \times 0.113''$) nail.

g. Fasteners spaced 3 inches on center at exterior edges and 6 inches on center at intermediate supports, when used as structural sheathing. Spacing shall be 6 inches on center on the edges and 12 inches on center at intermediate supports for nonstructural applications.

h. Corrosion-resistant roofing nails with $^7/_{16}$-inch-diameter head and $1^1/_2$-inch length for $^1/_2$-inch sheathing and $1\ ^3/_4$-inch length for $^{25}/_{32}$-inch sheathing.

i. Corrosion-resistant staples with nominal $^7/_{16}$-inch crown and $1\ ^1/_8$-inch length for $^1/_2$-inch sheathing and $1\ ^1/_2$-inch length for $^{25}/_{32}$-inch sheathing. Panel supports at 16 inches (20 inches if strength axis in the long direction of the panel, unless otherwise marked).

j. Casing ($1^1/_2'' \times 0.080''$) or finish ($1^1/_2'' \times 0.072''$) nails spaced 6 inches on panel edges, 12 inches at intermediate supports.

k. Panel supports at 24 inches. Casing or finish nails spaced 6 inches on panel edges, 12 inches at intermediate supports.

l. For roof sheathing applications, 8d nails ($2^1/_2'' \times 0.113''$) are the minimum required for wood structural panels.

m. Staples shall have a minimum crown width of $^7/_{16}$ inch.

n. For roof sheathing applications, fasteners spaced 4 inches on center at edges, 8 inches at intermediate supports.

o. Fasteners spaced 4 inches on center at edges, 8 inches at intermediate supports for subfloor and wall sheathing and 3 inches on center at edges, 6 inches at intermediate supports for roof sheathing.

p. Fasteners spaced 4 inches on center at edges, 8 inches at intermediate supports.

2304.10.1 Columns. Columns shall be continuous or superimposed throughout all stories by means of reinforced concrete or metal caps with brackets, or shall be connected by properly designed steel or iron caps, with pintles and base plates, or by timber splice plates affixed to the columns by metal connectors housed within the contact faces, or by other approved methods.

2304.10.1.1 Column connections. Girders and beams shall be closely fitted around columns and adjoining ends shall be cross tied to each other, or intertied by caps or ties, to transfer horizontal loads across joints. Wood bolsters shall not be placed on tops of columns unless the columns support roof loads only.

2304.10.2 Floor framing. Approved wall plate boxes or hangers shall be provided where wood beams, girders or trusses rest on masonry or concrete walls. Where intermediate beams are used to support a floor, they shall rest on top of girders, or shall be supported by ledgers or blocks securely fastened to the sides of the girders, or they shall be supported by an approved metal hanger into which the ends of the beams shall be closely fitted.

2304.10.3 Roof framing. Every roof girder and at least every alternate roof beam shall be anchored to its supporting member; and every monitor and every sawtooth construction shall be anchored to the main roof construction. Such anchors shall consist of steel or iron bolts of sufficient strength to resist vertical uplift of the roof.

2304.10.4 Floor decks. Floor decks and covering shall not extend closer than $^1/_2$ inch (12.7 mm) to walls. Such $^1/_2$-inch (12.7 mm) spaces shall be covered by a molding fastened to the wall either above or below the floor and arranged such that the molding will not obstruct the expansion or contraction movements of the floor. Corbeling of masonry walls under floors is permitted in place of such molding.

2304.10.5 Roof decks. Where supported by a wall, roof decks shall be anchored to walls to resist uplift forces determined in accordance with Chapter 16. Such anchors shall consist of steel or iron bolts of sufficient strength to resist vertical uplift of the roof.

2304.11 Protection against decay and termites.

2304.11.1 General. Where required by this section, protection from decay and termites shall be provided by the use of naturally durable or preservative-treated wood.

2304.11.2 Wood used above ground. Wood used above ground in the locations specified in Sections 2304.11.2.1 through 2304.11.2.7, 2304.11.3 and 2304.11.5 shall be naturally durable wood or preservative-treated wood using water-borne preservatives, in accordance with AWPA U1 (Commodity Specifications A or F) for above-ground use.

2304.11.2.1 Joists, girders and subfloor. Where wood joists or the bottom of a wood structural floor without joists are closer than 18 inches (457 mm), or wood girders are closer than 12 inches (305 mm) to the exposed ground in crawl spaces or unexcavated areas located within the perimeter of the building foundation, the floor assembly (including posts, girders, joists and subfloor) shall be of naturally durable or preservative-treated wood.

2304.11.2.2 Wood supported by exterior foundation walls. Wood framing members, including wood sheathing, that rest on exterior foundation walls and are less than 8 inches (203 mm) from exposed earth shall be of naturally durable or preservative-treated wood. Wood framing members and furring strips attached directly to masonry or concrete walls shall be of approved naturally durable or preservative-treated wood.

2304.11.2.3 Exterior walls below grade. Wood framing members and furring strips attached directly to the interior of exterior masonry or concrete walls below grade shall be of approved naturally durable or preservative-treated wood.

2304.11.2.4 Sleepers and sills. Sleepers and sills on a concrete or masonry slab that is in direct contact with earth shall be of naturally durable or preservative-treated wood.

2304.11.2.5 Girder ends. The ends of wood girders entering exterior masonry or concrete walls shall be provided with a $^1/_2$-inch (12.7 mm) air space on top, sides and end, unless naturally durable or preservative-treated wood is used.

2304.11.2.6 Wood siding. Clearance between wood siding and earth on the exterior of a building shall not be less than 6 inches (152 mm) except where siding, sheathing and wall framing are of naturally durable or preservative-treated wood.

2304.11.2.7 Posts or columns. Posts or columns supporting permanent structures and supported by a concrete or masonry slab or footing that is in direct contact with the earth shall be of naturally durable or preservative-treated wood.

Exceptions:

1. Posts or columns that are either exposed to the weather or located in basements or cellars, supported by concrete piers or metal pedestals projected at least 1 inch (25 mm) above the slab or deck and 6 inches (152 mm) above exposed earth, and are separated therefrom by an impervious moisture barrier.
2. Posts or columns in enclosed crawl spaces or unexcavated areas located within the periphery of the building, supported by a concrete pier or metal pedestal at a height greater than 8 inches (203 mm) from exposed ground, and are separated therefrom by an impervious moisture barrier.

2304.11.3 Laminated timbers. The portions of glued-laminated timbers that form the structural supports of a building or other structure and are exposed to weather and not fully protected from moisture by a roof, eave or similar covering shall be pressure treated with preservative or be manufactured from naturally durable or preservative-treated wood.

2304.11.4 Wood in contact with the ground or fresh water. Wood used in contact with the ground (exposed earth) in the locations specified in Sections 2304.11.4.1 and 2304.11.4.2 shall be naturally durable (species for both decay and termite resistance) or preservative treated using water-borne preservatives in accordance with AWPA U1 (Commodity Specifications A or F) for soil or fresh water use.

Exception: Untreated wood is permitted where such wood is continuously and entirely below the ground-water level or submerged in fresh water.

2304.11.4.1 Posts or columns. Posts and columns supporting permanent structures that are embedded in concrete that is in direct contact with the earth, embedded in concrete that is exposed to the weather or in direct contact with the earth shall be of preservative-treated wood.

2304.11.4.2 Wood structural members. Wood structural members that support moisture-permeable floors or roofs that are exposed to the weather, such as concrete or masonry slabs, shall be of naturally durable or preservative-treated wood unless separated from such floors or roofs by an impervious moisture barrier.

2304.11.4.3 Decks, fences, patios, planters or other wooden building components that directly abut the sidewall of the foundation or structure shall be constructed so as to provide:

1. Eighteen-inch (457 mm) clearance beneath, or
2. Six-inch (152 mm) clearance between the top of the component and the exterior wall covering or
3. have components that are easily removable by screws or hinges to allow access for inspection of the foundation sidewall and treatment for termites.

2304.11.5 Supporting member for permanent appurtenances. Naturally durable or preservative-treated wood shall be utilized for those portions of wood members that form the structural supports of buildings, balconies, porches or similar permanent building appurtenances where such members are exposed to the weather without adequate protection from a roof, eave, overhang or other covering to prevent moisture or water accumulation on the surface or at joints between members.

Exception: When a building is located in a geographical region where experience has demonstrated that climatic conditions preclude the need to use durable materials where the structure is exposed to the weather.

2304.11.6 Termite protection. Termite protection shall be provided by floor framing of naturally durable or preservative-treated wood, soil treatment or other approved methods of termite protection.

2304.11.7 Wood used in retaining walls and cribs. Wood installed in retaining or crib walls shall be preservative treated in accordance with AWPA U1 (Commodity Specifications A or F) for soil and fresh water use.

2304.11.8 Attic ventilation. For attic ventilation, see Section 1203.2.

2304.11.9 Under-floor ventilation (crawl space). For under-floor ventilation (crawl space), see Section 1203.3.

2304.11.10 Foam-plastic insulation.

2304.11.10.1 The provisions of Section 2603.8 shall apply to the installation of foam plastic insulation in close proximity to the ground.

Exception: Materials which are of naturally durable wood or are pressure treated for ground contact, and which are installed with at least 6 inches (152 mm) clear space from the structure to allow for inspection and treatment for termites.

In order to reduce chances of termite infestation, no wood, vegetation, stumps, dead roots, cardboard, trash or other cellulose-containing material shall be buried on the building lot within 15 feet (4.6 m) of any building or the position of any building proposed to be built.

2304.12 Long-term loading. Wood members supporting concrete, masonry or similar materials shall be checked for the effects of long-term loading using the provisions of the AF&PA NDS. The total deflection, including the effects of long-term loading, shall be limited in accordance with Section 1604.3.1 for these supported materials.

Exception: Horizontal wood members supporting masonry or concrete nonstructural floor or roof surfacing not more than 4 inches (102 mm) thick need not be checked for long-term loading.

2304.13 Preparation of building site and removal of debris.

2304.13.1 All building sites shall be graded to provide drainage under all portions of the building not occupied by basements.

2304.13.2 The foundation and the area encompassed within 1 foot (305 mm) therein shall have all vegetation, stumps, dead roots, cardboard, trash and foreign material removed and the fill material shall be free of vegetation and foreign material. The fill shall be compacted to assure adequate support of the foundation.

2304.13.3 After all work is completed, loose wood and debris shall be completely removed from under the building and within 1 foot (305 mm) thereof. All wood forms and supports shall be completely removed. This includes, but is not limited to: wooden grade stakes, forms, contraction spacers, tub trap boxes, plumbing supports, bracing, shoring, forms or other cellulose-containing material placed in any location where such materials are not clearly visible and readily removable prior to completion of the work. Wood shall not be stored in contact with the ground under any building.

SECTION 2305
GENERAL DESIGN REQUIREMENTS FOR LATERAL-FORCE-RESISTING SYSTEMS

2305.1 General. Structures using wood shear walls and diaphragms to resist wind, and other lateral loads shall be designed and constructed in accordance with the provisions of this section. Alternatively, compliance with the AF&PA SDPWS shall be permitted subject to the limitations therein and the limitations of this code.

2305.1.1 Shear resistance based on principles of mechanics. Shear resistance of diaphragms and shear walls are permitted to be calculated by principles of mechanics using values of fastener strength and sheathing shear resistance.

2305.1.2 Framing. Boundary elements shall be provided to transmit tension and compression forces. Perimeter members at openings shall be provided and shall be detailed to distribute the shearing stresses. Diaphragm and shear wall sheathing shall not be used to splice boundary elements. Diaphragm chords and collectors shall be placed in, or tangent to, the plane of the diaphragm framing unless it can be demonstrated that the moments, shears and deformations, considering eccentricities resulting from other configurations can be tolerated without exceeding the adjusted resistance and drift limits.

2305.1.2.1 Framing members. Framing members shall be at least 2 inch (51 mm) nominal width. In general, adjoining panel edges shall bear and be attached to the framing members and butt along their centerlines. Nails shall be placed not less than $^3/_8$ inch (9.5 mm) from the panel edge, not more than 12 inches (305 mm) apart along intermediate supports, and 6 inches (152 mm) along panel edge bearings, and shall be firmly driven into the framing members.

2305.1.3 Openings in shear panels. Openings in shear panels that materially affect their strength shall be fully detailed on the plans, and shall have their edges adequately reinforced to transfer all shearing stresses.

2305.1.4 Shear panel connections. Positive connections and anchorages, capable of resisting the design forces, shall be provided between the shear panel and the attached components.

2305.1.5 Wood members resisting horizontal seismic forces contributed by masonry and concrete walls. Reserved.

2305.1.6 Wood members resisting seismic forces from nonstructural concrete or masonry. Reserved.

2305.2 Design of wood diaphragms.

2305.2.1 General. Wood diaphragms are permitted to be used to resist horizontal forces provided the deflection in the plane of the diaphragm, as determined by calculations, tests or analogies drawn therefrom, does not exceed the permissible deflection of attached distributing or resisting elements. Connections shall extend into the diaphragm a sufficient distance to develop the force transferred into the diaphragm.

2305.2.2 Deflection. Permissible deflection shall be that deflection up to which the diaphragm and any attached distributing or resisting element will maintain its structural integrity under design load conditions, such that the resisting element will continue to support design loads without danger to occupants of the structure. Calculations for diaphragm deflection shall account for the usual bending and shear components as well as any other factors, such as nail deformation, which will contribute to deflection.

The deflection (Δ) of a blocked wood structural panel diaphragm uniformly nailed throughout is permitted to be calculated by using the following equation. If not uniformly nailed, the constant 0.188 (For SI: $^1/_{1627}$) in the third term must be modified accordingly.

$$\Delta = \frac{5vL^3}{8EAb} + \frac{vL}{4Gt} + 0.188Le_n + \frac{\Sigma(\Delta_c X)}{2b} \qquad \textbf{(Equation 23-1)}$$

For SI: $\Delta = \dfrac{0.052vL^3}{EAb} + \dfrac{vL}{4Gt} + \dfrac{Le_n}{1627} + \dfrac{\Sigma(\Delta_c X)}{2b}$

where:

A = Area of chord cross section, in square inches (mm^2).

b = Diaphragm width, in feet (mm).

E = Elastic modulus of chords, in pounds per square inch (N/mm^2).

e_n = Nail or staple deformation, in inches (mm) [see Table 2305.2.2(1)].

Gt = Panel rigidity through the thickness, in pounds per inch (N/mm) of panel width or depth [see Table 2305.2.2(2)].

L = Diaphragm length, in feet (mm).

v = Maximum shear due to design loads in the direction under consideration, in pounds per linear foot (plf) (N/mm).

Δ = The calculated deflection, in inches (mm).

TABLE 2305.2.2(1)
e_n VALUES (inches) FOR USE IN CALCULATING DIAPHRAGM DEFLECTION DUE TO FASTENER SLIP (Structural I)[a,d]

LOAD PER FASTENER[c] (pounds)	FASTENER DESIGNATIONS[b]			
	6d	8d	10d	14-Ga staple x 2 inches long
60	0.01	0.00	0.00	0.011
80	0.02	0.01	0.01	0.018
100	0.03	0.01	0.01	0.028
120	0.04	0.02	0.01	0.04
140	0.06	0.03	0.02	0.053
160	0.10	0.04	0.02	0.068
180	—	0.05	0.03	—
200	—	0.07	0.47	—
220	—	0.09	0.06	—
240	—	—	0.07	—

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.448 N.

a. Increase e_n values 20 percent for plywood grades other than Structural I.

b. Nail values apply to common wire nails or staples identified.

c. Load per fastener = maximum shear per foot divided by the number of fasteners per foot at interior panel edges.

d. Decrease e_n values 50 percent for seasoned lumber (moisture content < 19 percent).

TABLE 2305.2.2(2)
VALUES OF *Gt* FOR USE IN CALCULATING DEFLECTION OF WOOD STRUCTURAL PANEL SHEAR WALLS AND DIAPHRAGMS

PANEL TYPE	SPAN RATING	VALUES OF *Gt* (lb/in. panel depth or width)							
		OTHER				STRUCTURAL I			
		3-ply Plywood	4-ply Plywood	5-ply Plywood[a]	OSB	3-ply Plywood	4-ply Plywood	5-ply Plywood[a]	OSB
Sheathing	24/0	25,000	32,500	37,500	77,500	32,500	42,500	41,500	77,500
	24/16	27,000	35,000	40,500	83,500	35,000	45,500	44,500	83,500
	32/16	27,000	35,000	40,500	83,500	35,000	45,500	44,500	83,500
	40/20	28,500	37,000	43,000	88,500	37,000	48,000	47,500	88,500
	48/24	31,000	40,500	46,500	96,000	40,500	52,500	51,000	96,000
Single Floor	16 o.c.	27,000	35,000	40,500	83,500	35,000	45,500	44,500	83,500
	20 o.c.	28,000	36,500	42,000	87,000	36,500	47,500	46,000	87,000
	24 o.c.	30,000	39,000	45,000	93,000	39,000	50,500	49,500	93,000
	32 o.c.	36,000	47,000	54,000	110,000	47,000	61,000	59,500	110,000
	48 o.c.	50,500	65,500	76,000	155,000	65,500	85,000	83,500	155,000

		OTHER			STRUCTURAL I		
	Thickness (in.)	A-A, A-C	Marine	All Other Grades	A-A, A-C	Marine	All Other Grades
Sanded Plywood	1/4	24,000	31,000	24,000	31,000	31,000	31,000
	11/32	25,500	33,000	25,500	33,000	33,000	33,000
	3/8	26,000	34,000	26,000	34,000	34,000	34,000
	15/32	38,000	49,500	38,000	49,500	49,500	49,500
	1/2	38,500	50,000	38,500	50,000	50,000	50,000
	19/32	49,000	63,500	49,000	63,500	63,500	63,500
	5/8	49,500	64,500	49,500	64,500	64,500	64,500
	23/32	50,500	65,500	50,500	65,500	65,500	65,500
	3/4	51,000	66,500	51,000	66,500	66,500	66,500
	7/8	52,500	68,500	52,500	68,500	68,500	68,500
	1	73,500	95,500	73,500	95,500	95,500	95,500
	1 1/8	75,000	97,500	75,000	97,500	97,500	97,500

For SI: 1 inch = 25.4 mm, 1 pound/inch = 0.1751 N/mm.

a. Applies to plywood with five or more layers; for five-ply/three-layer plywood, use values for four ply.

$\Sigma(\Delta_c X)$ = Sum of individual chord-splice slip values on both sides of the diaphragm, each multiplied by its distance to the nearest support.

2305.2.3 Diaphragm aspect ratios. Size and shape of diaphragms shall be limited as set forth in Table 2305.2.3.

TABLE 2305.2.3
MAXIMUM DIAPHRAGM DIMENSION RATIOS HORIZONTAL AND SLOPED DIAPHRAGM

TYPE	MAXIMUM LENGTH - WIDTH RATIO
Wood structural panel, nailed all edges	4:1
Wood structural panel, blocking omitted at intermediate joints	3:1
Diagonal sheathing, single	3:1
Diagonal sheathing, double	4:1

2305.2.4 Construction. Wood diaphragms shall be constructed of wood structural panels manufactured with exterior glue and not less than 4 feet by 8 feet (1219 mm by 2438 mm), except at boundaries and changes in framing where minimum sheet dimension shall be 24 inches (610 mm) unless all edges of the undersized sheets are supported by and fastened to framing members or blocking. Wood structural panel thickness for horizontal diaphragms shall not be less than the valves set forth in Tables 2304.7(3), 2304.7(4) and 2304.7(5) for corresponding joist spacing and loads.

2305.2.4.1 Seismic Design Category F. Reserved.

2305.2.5 Rigid diaphragms. Design of structures with rigid diaphragms shall conform to the structure configuration requirements of Section 12.3.2 of ASCE 7 and the horizontal shear distribution requirements of Section 12.8.4 of ASCE 7.

Open-front structures with rigid wood diaphragms resulting in torsional force distribution are permitted, provided the length, *l*, of the diaphragm normal to the open side does not exceed 25 feet (7620 mm), the diaphragm sheathing conforms to Section 2305.2.4 and the *l*/*w* ratio [as shown in Figure 2305.2.5(1)] is less than 1 for one-story structures or 0.67 for structures over one story in height.

Exception: Where calculations show that diaphragm deflections can be tolerated, the length, *l*, normal to the open end is permitted to be increased to a *l*/*w* ratio not greater than 1.5 where sheathed in compliance with Section 2305.2.4 or to 1 where sheathed in compliance with Section 2306.3.4 or 2306.3.5.

Rigid wood diaphragms are permitted to cantilever past the outermost supporting shearwall (or other vertical resisting element) a length, *l*, of not more than 25 feet (7620 mm) or two-thirds of the diaphragm width, *w*, whichever is smaller. Figure 2305.2.5(2) illustrates the dimensions of *l* and *w* for a cantilevered diaphragm.

2305.3 Design of wood shear walls.

2305.3.1 General. Wood shear walls are permitted to resist horizontal forces in vertical distributing or resisting elements, provided the deflection in the plane of the shearwall, as determined by calculations, tests or analogies drawn therefrom, does not exceed the more restrictive of the permissible deflection of attached distributing or resisting elements.

2305.3.2 Deflection. Permissible deflection shall be that deflection up to which the shear wall and any attached distributing or resisting element will maintain its structural integrity under design load conditions, i.e., continue to support design loads without danger to occupants of the structure.

The deflection (Δ) of a blocked wood structural panel shear wall uniformly fastened throughout is permitted to be calculated by the use of the following equation:

$$\Delta = \frac{8vh^3}{EAb} + \frac{vh}{Gt} + 0.75he_n + d_a\frac{h}{b} \qquad \textbf{(Equation 23-2)}$$

For SI: $$\Delta = \frac{vh^3}{3EAb} + \frac{vh}{Gt} + \frac{he_n}{407.6} + d_a\frac{h}{b}$$

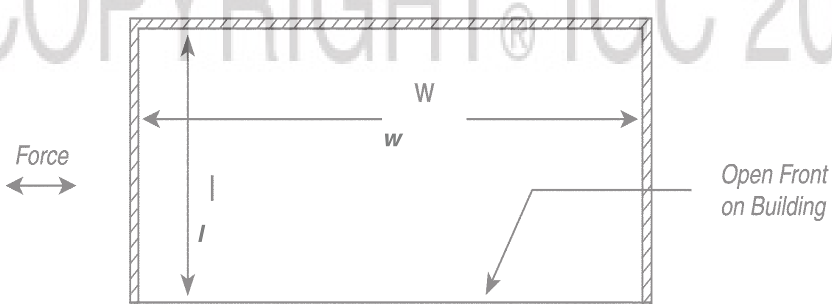


FIGURE 2305.2.5(1)
DIAPHRAGM LENGTH AND WIDTH FOR PLAN VIEW OF OPEN-FRONT BUILDING

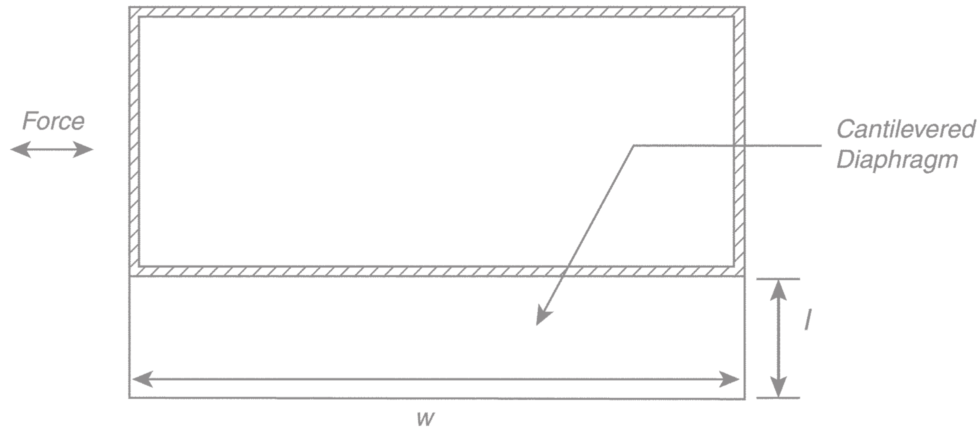


FIGURE 2305.2.5(2)
DIAPHRAGM LENGTH AND WIDTH FOR PLAN VIEW OF CANTILEVERED DIAPHRAGM

where:

A = Area of boundary element cross section in square inches (mm^2) (vertical member at shear wall boundary).

b = Wall width, in feet (mm).

d_a = Vertical elongation of overturning anchorage (including fastener slip, device elongation, anchor rod elongation, etc.) at the design shear load (v).

E = Elastic modulus of boundary element (vertical member at shear wall boundary), in pounds per square inch (N/mm^2).

e_n = Nail or staple deformation, in inches (mm) [see Table 2305.2.2(1)].

Gt = Panel rigidity through the thickness, in pounds per inch (N/mm) of panel width or depth [see Table 2305.2.2(2)].

h = Wall height, in feet (mm).

v = Maximum shear due to design loads at the top of the wall, in pounds per linear foot (N/mm).

Δ = The calculated deflection, in inches (mm).

2305.3.3 Construction. Wood shear walls shall be constructed of wood structural panels manufactured with exterior glue and not less than 4 feet by 8 feet (1219 mm by 2438 mm), except at boundaries and at changes in framing. All edges of all panels shall be supported by and fastened to framing members or blocking. Wood structural panel thickness for shear walls shall not be less than set forth in Table 2304.6.1 for corresponding framing spacing and loads, except that $^1/_4$ inch (6.4 mm) is permitted to be used where perpendicular loads permit.

TABLE 2305.3.4
MAXIMUM SHEAR WALL DIMENSION RATIOS

TYPE	MAXIMUM HEIGHT-WIDTH RATIO
Wood structural panels or particleboard, nailed edges	$3^1/_2$:1
Diagonal sheathing, single	2:1
Fiberboard	$1^1/_2$:1
Gypsum board, gypsum lath, cement plaster	$1^1/_2$:1[b]

a. Reserved.

b. Ratio shown is for unblocked construction. Height-to-width ratio is permitted to be 2:1 where the wall is installed as blocked construction in accordance with Section 2306.4.5.1.2.

2305.3.4 Shear wall aspect ratios. Size and shape of shear walls, perforated shear wall segments within perforated shear walls and wall piers within shear walls that are designed for force transfer around openings shall be limited as set forth in Table 2305.3.4. The height, h, and the width, w, shall be determined in accordance with Sections 2305.3.5 through 2305.3.5.2 and 2305.3.6 through 2305.3.6.2, respectively.

2305.3.5 Shear wall height definition. The height of a shear wall, h, shall be defined as:

1. The maximum clear height from the top of the foundation to the bottom of the diaphragm framing above; or
2. The maximum clear height from the top of the diaphragm to the bottom of the diaphragm framing above [see Figure 2305.3.5(a)].

2305.3.5.1 Perforated shear wall segment height definition. The height of a perforated shear wall segment, h, shall be defined as specified in Section 2305.3.5 for shear walls.

2305.3.5.2 Force transfer shear wall pier height definition. The height, h, of a wall pier in a shear wall with openings designed for force transfer around openings shall be defined as the clear height of the pier at the side of an opening [see Figure 2305.3.5(b)].

2305.3.6 Shear wall width definition. The width of a shear wall, *w*, shall be defined as the sheathed dimension of the shear wall in the direction of application of force [see Figure 2305.3.5(a)].

2305.3.6.1 Perforated shear wall segment width definition. The width of a perforated shear wall segment, *w*, shall be defined as the width of full-height sheathing adjacent to openings in the perforated shear wall [see Figure 2305.3.5(a)].

2305.3.6.2 Force transfer shear wall pier width definition. The width, *w*, of a wall pier in a shear wall with openings designed for force transfer around openings shall be defined as the sheathed width of the pier at the side of an opening [see Figure 2305.3.5(b)].

2305.3.7 Overturning restraint. Where the dead load stabilizing moment in accordance with Chapter 16 allowable stress design load combinations is not sufficient to prevent uplift due to overturning moments on the wall, an anchoring device shall be provided. Anchoring devices shall maintain a continuous load path to the foundation.

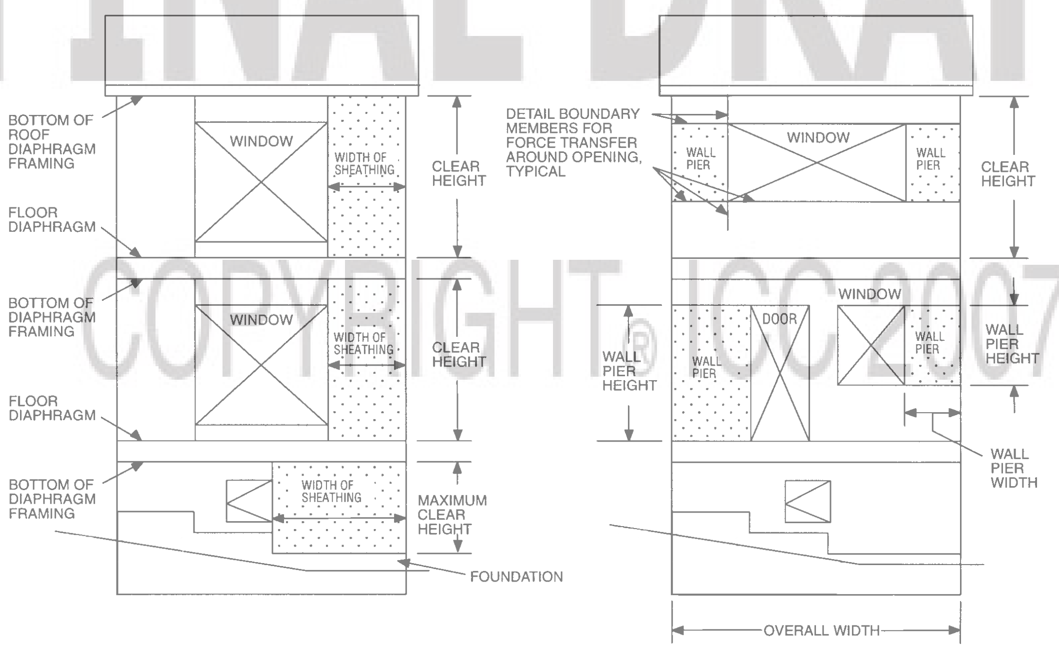
2305.3.8 Shear walls with openings. The provisions of this section shall apply to the design of shear walls with openings. Where framing and connections around the openings are designed for force transfer around the openings, the provisions of Section 2305.3.8.1 shall apply. Where framing and connections around the openings are not designed for force transfer around the openings, the provisions of Section 2305.3.8.2 shall apply.

2305.3.8.1 Force transfer around openings. Where shear walls with openings are designed for force transfer around the openings, the limitations of Table 2305.3.4 shall apply to the overall shear wall, including openings, and to each wall pier at the side of an opening. Design for force transfer shall be based on a rational analysis. Detailing of boundary elements around the opening shall be provided in accordance with the provisions of this section[see Figure 2305.3.5(b)].

2305.3.8.2 Perforated shear walls. The provisions of Section 2305.3.8.2 shall be permitted to be used for the design of perforated shear walls. For the determination of the height and width of perforated shear wall segments, see Sections 2305.3.5.1 and 2305.3.6.1, respectively.

2305.3.8.2.1 Limitations. The following limitations shall apply to the use of Section 2305.3.8.2:

1. A perforated shear wall segment shall be located at each end of a perforated shear wall. Openings shall be permitted to occur beyond the ends of the perforated shear wall, provided the width of such openings is not be included in the width of the perforated shear wall.
2. The allowable shear set forth in Table 2306.4.1 shall not exceed 490 plf (7150 N/m).



(a) HEIGHT-TO-WIDTH RATIO FOR SHEAR WALLS AND PERFORATED SHEAR WALLS

(b) HEIGHT-TO-WIDTH RATIO WITH DESIGN FOR FORCE TRANSFER AROUND OPENINGS

FIGURE 2305.3.5
GENERAL DEFINITION OF SHEAR WALL HEIGHT, WIDTH AND HEIGHT-TO-WIDTH RATIO

3. Where out-of-plane offsets occur, portions of the wall on each side of the offset shall be considered as separate perforated shear walls.
4. Collectors for shear transfer shall be provided through the full length of the perforated shear wall.
5. A perforated shear wall shall have uniform top of wall and bottom of wall elevations. Perforated shear walls not having uniform elevations shall be designed by other methods.
6. Perforated shear wall height, h, shall not exceed 20 feet (6096 mm).

2305.3.8.2.2 Perforated shear wall resistance. The resistance of a perforated shear wall shall be calculated in accordance with the following:

1. The percentage of full-height sheathing shall be calculated as the sum of the widths of perforated shear wall segments divided by the total width of the perforated shear wall, including openings.
2. The maximum opening height shall be taken as the maximum opening clear height. Where areas above and below an opening remain unsheathed, the height of the opening shall be defined as the height of the wall.
3. The unadjusted shear resistance shall be the allowable shear set forth in Table 2306.4.1 for height-to-width ratios of perforated shear wall segments that do not exceed $3^1/_2$:1
4. The adjusted shear resistance shall be calculated by multiplying the unadjusted shear resistance by the shear resistance adjustment factors of Table 2305.3.8.2. For intermediate percentages of full-height sheathing, the values in Table 2305.3.8.2 are permitted to be interpolated.
5. The perforated shear wall resistance shall be equal to the adjusted shear resistance times the sum of the widths of the perforated shear wall segments.

2305.3.8.2.3 Anchorage and load path. Design of perforated shear wall anchorage and load path shall conform to the requirements of Sections 2305.3.8.2.4 through 2305.3.8.2.8, or shall be calculated using principles of mechanics. Except as modified by these sections, wall framing, sheathing, sheathing attachment and fastener schedules shall conform to the requirements of Section 2305.2.4 and Table 2306.4.1.

2305.3.8.2.4 Uplift anchorage at perforated shear wall ends. Anchorage for uplift forces due to overturning shall be provided at each end of the perforated shear wall. The uplift anchorage shall conform to the requirements of Section 2305.3.7, except that for each story the minimum tension chord uplift force, T, shall be calculated in accordance with the following:

$$T = \frac{Vh}{C_o \Sigma L_i} \qquad \textbf{(Equation 23-3)}$$

where:

T = Tension chord uplift force, pounds (N).

V = Shear force in perforated shear wall, pounds (N).

TABLE 2305.3.8.2
SHEAR RESISTANCE ADJUSTMENT FACTOR, C_o

WALL HEIGHT, H	MAXIMUM OPENING HEIGHT[a]				
	H/3	H/2	2H/3	5H/6	H
8′ wall	2′-8″	4′-0″	5′-4″	6′-8″	8′-0″
10′ wall	3′-4″	5′-0″	6′-8″	8′-4″	10′-0″
Percentage of full-height sheathing[b]	Shear resistance adjustment factor				
10%	1.00	0.69	0.53	0.43	0.36
20%	1.00	0.71	0.56	0.45	0.38
30%	1.00	0.74	0.59	0.49	0.42
40%	1.00	0.77	0.63	0.53	0.45
50%	1.00	0.80	0.67	0.57	0.50
60%	1.00	0.83	0.71	0.63	0.56
70%	1.00	0.87	0.77	0.69	0.63
80%	1.00	0.91	0.83	0.77	0.71
90%	1.00	0.95	0.91	0.87	0.83
100%	1.00	1.00	1.00	1.00	1.00

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. See Section 2305.3.8.2.2, Item 2.

b. See Section 2305.3.8.2.2, Item 1.

h = Perforated shear wall height, feet (mm).

C_o = Shear resistance adjustment factor from Table 2305.3.8.2.

$\sum L_i$ = Sum of widths of perforated shear wall segments, feet (mm).

2305.3.8.2.5 Anchorage for in-plane shear. The unit shear force, v, transmitted into the top of a perforated shear wall, out of the base of the perforated shear wall at full height sheathing and into collectors connecting shear wall segments shall be calculated in accordance with the following:

$$v = \frac{V}{C_o \Sigma L_i} \qquad \textbf{(Equation 23-4)}$$

where:

v = Unit shear force, pounds per lineal feet (N/m).

V = Shear force in perforated shear wall, pounds (N).

C_o = Shear resistance adjustment factor from Table 2305.3.8.2.

$\sum L_i$ = Sum of widths of perforated shear wall segments, feet (mm).

2305.3.8.2.6 Uplift anchorage between perforated shear wall ends. In addition to the requirements of Section 2305.3.8.2.4, perforated shear wall bottom plates at full-height sheathing shall be anchored for a uniform uplift force, t, equal to the unit shear force, v, determined in Section 2305.3.8.2.5.

2305.3.8.2.7 Compression chords. Each end of each perforated shear wall segment shall be designed for a compression chord force, C, equal to the tension chord uplift force, T, calculated in Section 2305.3.8.2.4.

2305.3.8.2.8 Load path. Load path. A load path to the foundation shall be provided for each uplift force, T and t, for each shear force, V and v, and for each compression chord force, C. Elements resisting shear wall forces contributed by multiple stories shall be designed for the sum of forces contributed by each story.

2305.3.8.2.9 Deflection of shear walls with openings. The controlling deflection of a blocked shear wall with openings uniformly fastened throughout shall be taken as the maximum individual deflection of the shear wall segments calculated in accordance with Section 2305.3.2, divided by the appropriate shear resistance adjustment factors of Table 2305.3.8.2.

2305.3.9 Summing shear capacities. The shear values for shear panels of different capacities applied to the same side of the wall are not cumulative except as allowed in Table 2306.4.1.

The shear values for material of the same type and capacity applied to both faces of the same wall are cumulative. Where the material capacities are not equal, the allowable shear shall be either two times the smaller shear capacity or the capacity of the stronger side, whichever is greater.

Summing shear capacities of dissimilar materials applied to opposite faces or to the same wall line is not allowed.

Exception: For wind design, the allowable shear capacity of shear wall segments sheathed with a combination of wood structural panels and gypsum wallboard on opposite faces, fiberboard structural sheathing and gypsum wallboard on opposite faces or hardboard panel siding and gypsum wallboard on opposite faces shall equal the sum of the sheathing capacities of each face separately.

2305.3.10 Adhesives. Adhesive attachment of shear wall sheathing is not permitted as a substitute for mechanical fasteners, and shall not be used in shear wall strength calculations alone.

2305.3.11 Sill plate size and anchorage in Seismic Design Category D, E or F. Reserved.

SECTION 2306
ALLOWABLE STRESS DESIGN

2306.1 Allowable stress design. The structural analysis and construction of wood elements in structures using allowable stress design shall be in accordance with the following applicable standards:

American Forest & Paper Association.

NDS National Design Specification for Wood Construction

American Institute of Timber Construction.

AITC 104	Typical Construction Details
AITC 110	Standard Appearance Grades for Structural Glued Laminated Timber
AITC 113	Standard for Dimensions of Structural Glued Laminated Timber
AITC 117	Standard Specifications for Structural Glued Laminated Timber of Softwood Species
AITC 119	Structural Standard Specifications for Glued Laminated Timber of Hardwood Species
AITC A190.1	Structural Glued Laminated Timber
AITC 200	Inspection Manual

American Society of Agricultural Engineers.

ASAE EP 484.2	Diaphragm Design of Metal-Clad, Post-Frame Rectangular Buildings
ASAE EP 486.1	Shallow Post Foundation Design
ASAE 559	Design Requirements and Bending Properties for Mechanically Laminated Columns

APA—The Engineered Wood Association.

Panel Design Specification

Plywood Design Specification Supplement 1 - Design & Fabrication of Plywood Curved Panel

Plywood Design Specification Supplement 2 - Design & Fabrication of Glued Plywood-Lumber Beams

Plywood Design Specification Supplement 3 - Design & Fabrication of Plywood Stressed-Skin Panels

Plywood Design Specification Supplement 4 - Design & Fabrication of Plywood Sandwich Panels

Plywood Design Specification Supplement 5 - Design & Fabrication of All-Plywood Beams

EWS T300 Glulam Connection Details

EWS S560 Field Notching and Drilling of Glued Laminated Timber Beams

EWS S475 Glued Laminated Beam Design Tables

EWS X450 Glulam in Residential Construction

EWS X440 Product and Application Guide: Glulam

EWS R540 Builders Tips: Proper Storage and Handling of Glulam Beams

Truss Plate Institute, Inc.

TPI 1 National Design Standard for Metal Plate Connected Wood Truss Construction

2306.1.1 Joists and rafters. The design of rafter spans is permitted to be in accordance with the *AF&PA Span Tables for Joists and Rafters*.

2306.1.2 Plank and beam flooring. The design of plank and beam flooring is permitted to be in accordance with the *AF&PA Wood Construction Data No. 4*.

2306.1.3 Treated wood stress adjustments. The allowable unit stresses for preservative-treated wood need no adjustment for treatment, but are subject to other adjustments.

The allowable unit stresses for fire-retardant-treated wood, including fastener values, shall be developed from an approved method of investigation that considers the effects of anticipated temperature and humidity to which the fire-retardant-treated wood will be subjected, the type of treatment and the redrying process. Other adjustments are applicable except that the impact load duration shall not apply.

2306.1.4 Lumber decking. The capacity of lumber decking arranged according to the patterns described in Section 2304.8.2 shall be the lesser of the capacities determined for flexure and deflection according to the formulas in Table 2306.1.4.

TABLE 2306.1.4
ALLOWABLE LOADS FOR LUMBER DECKING

PATTERN	ALLOWABLE AREA LOAD[a,b]	
	Flexure	Deflection
Simple span	$\sigma_b = \frac{8F'_b}{l^2}\frac{d^2}{6}$	$\sigma_\Delta = \frac{384\Delta E'}{5l^4}\frac{d^3}{12}$
Two-span continuous	$\sigma_b = \frac{8F'_b}{l^2}\frac{d^2}{6}$	$\sigma_\Delta = \frac{185\Delta E'}{l^4}\frac{d^3}{12}$
Combination simple- and two-span continuous	$\sigma_b = \frac{8F'_b}{l^2}\frac{d^2}{6}$	$\sigma_\Delta = \frac{131\Delta E'}{l^4}\frac{d^3}{12}$
Cantilevered pieces intermixed	$\sigma_b = \frac{20F'_b}{3l^2}\frac{d^2}{6}$	$\sigma_\Delta = \frac{105\Delta E'}{l^4}\frac{d^3}{12}$
Controlled random layup		
Mechanically laminated decking	$\sigma_b = \frac{20F'_b}{3l^2}\frac{d^2}{6}$	$\sigma_\Delta = \frac{100\Delta E'}{l^4}\frac{d^3}{12}$
2-inch decking	$\sigma_b = \frac{20F'_b}{3l^2}\frac{d^2}{6}$	$\sigma_\Delta = \frac{100\Delta E'}{l^4}\frac{d^3}{12}$
3-inch and 4-inch decking	$\sigma_b = \frac{20F'_b}{3l^2}\frac{d^2}{6}$	$\sigma_\Delta = \frac{116\Delta E'}{l^4}\frac{d^3}{12}$

For SI: 1 inch = 25.4 mm.

a. σ_b = Allowable total uniform load limited by bending.
   σ_Δ = Allowable total uniform load limited by deflection.

b. d = Actual decking thickness.
   l = Span of decking.
   F'_b = Allowable bending stress adjusted by applicable factors.
   E' = Modulus of elasticity adjusted by applicable factors.

2306.2 Wind provisions for walls.

2306.2.1 Wall stud bending stress increase. The AF&PA NDS fiber stress in bending (F_b) design values for sawn lumber wood studs resisting out of plane wind loads shall be increased by the factors in Table 2306.2.1, in lieu of the 1.15 repetitive member factor. These increases take into consideration the load sharing and composite actions provided by the wood structural panels as defined in Section 2302.1. The increases shall apply where the studs are designed for bending and are spaced no more than 16 inches (406 mm) o.c., covered on the inside with a minimum of $^1/_2$-inch (12.7 mm) gypsum board fastened in accordance with Table 2306.4.5 and sheathed on the exterior with a minimum of $^3/_8$-inch (9.5 mm) wood structural panel sheathing. All panel joints shall occur over studs or blocking and shall be attached using a minimum of 8d common nails spaced a maximum of 6 inches o.c. (152 mm) at panel edges and 12 inches o.c. (305 mm) at intermediate framing members.

TABLE 2306.2.1
WALL STUD BENDING STRESS INCREASE FACTORS

STUD SIZE	SYSTEM FACTOR
2 × 4	1.5
2 × 6	1.35
2 × 8	1.25
2 × 10	1.2
2 × 12	1.15

2306.3 Wood diaphragms.

2306.3.1 Wood structural panel diaphragms. Wood structural panel diaphragms are permitted to resist horizontal forces using the allowable shear capacities set forth in Table 2306.3.1 or 2306.3.2. The allowable shear capacities are permitted to be calculated by principles of mechanics without limitations by using values for fastener strength in the AF&PA NDS, structural design properties for wood structural panels based on DOC PS-1 and DOC PS-2 or wood structural panel design properties given in the *APA Panel Design Specification* (PDS).

2306.3.2 Shear capacities modifications. The allowable shear capacities in Tables 2306.3.1 and 2306.3.2 for horizontal wood structural panel diaphragms shall be increased 40 percent for wind design.

2306.3.3 Diagonally sheathed lumber diaphragms. Diagonally sheathed lumber diaphragms shall be nailed in accordance with Table 2306.3.3.

2306.3.4 Single diagonally sheathed lumber diaphragms. Single diagonally sheathed lumber diaphragms shall be constructed of minimum 1-inch (25 mm) thick nominal sheathing boards laid at an angle of approximately 45 degrees (0.78 rad) to the supports. The shear capacity for single diagonally sheathed lumber diaphragms of southern pine or Douglas fir-larch shall not exceed 300 plf (4378 N/m) of width. The shear capacities shall be adjusted by reduction factors of 0.82 for framing members of species with a specific gravity equal to or greater than 0.42 but less than 0.49 and 0.65 for species with a specific gravity of less than 0.42, as contained in the AF&PA NDS.

2306.3.4.1 End joints. End joints in adjacent boards shall be separated by at least one stud or joist space and there shall be at least two boards between joints on the same support.

2306.3.4.2 Single diagonally sheathed lumber diaphragms. Single diagonally sheathed lumber diaphragms made up of 2-inch (51 mm) nominal diagonal lumber sheathing fastened with 16d nails shall be designed with the same shear capacities as shear panels using 1-inch (25 mm) boards fastened with 8d nails, provided there are not splices in adjacent boards on the same support and the supports are not less than 4 inch (102 mm) nominal depth or 3 inch (76 mm) nominal thickness.

2306.3.5 Double diagonally sheathed lumber diaphragms. Double diagonally sheathed lumber diaphragms shall be constructed of two layers of diagonal sheathing boards at 90 degrees (1.57 rad) to each other on the same face of the supporting members. Each chord shall be considered as a beam with uniform load per foot equal to 50 percent of the unit shear due to diaphragm action. The load shall be assumed as acting normal to the chord in the plan of the diaphragm in either direction. The span of the chord or portion thereof shall be the distance between framing members of the diaphragm, such as the joists, studs and blocking that serve to transfer the assumed load to the sheathing. The shear capacity of double diagonally sheathed diaphragms of Southern pine or Douglas fir-larch shall not exceed 600 plf (8756 kN/m) of width. The shear capacity shall be adjusted by reduction factors of 0.82 for framing members of species with a specific gravity equal to or greater than 0.42 but less than 0.49 and 0.65 for species with a specific gravity of less than 0.42, as contained in the AF&PA NDS. Nailing of diagonally sheathed lumber diaphragms shall be in accordance with Table 2306.3.3.

2306.3.6 Gypsum board diaphragm ceilings. Gypsum board diaphragm ceilings shall be in accordance with Section 2508.5.

2306.4 Shear walls. Panel sheathing joints in shear walls shall occur over studs or blocking. Adjacent panel sheathing joints shall occur over and be nailed to common framing members (see Section 2305.3.1 for limitations on shear wall bracing materials).

2306.4.1 Wood structural panel shear walls. The allowable shear capacities for wood structural panel shear walls shall be in accordance with Table 2306.4.1. These capacities are permitted to be increased 40 percent for wind design. Shear walls are permitted to be calculated by principles of mechanics without limitations by using values for nail strength given in the AF&PA NDS and wood structural

TABLE 2306.3.3
DIAGONALLY SHEATHED LUMBER DIAPHRAGM NAILING SCHEDULE

SHEATHING NOMINAL DIMENSION	NAILING TO INTERMEDIATE AND END-BEARING STUDS		NAILING AT THE SHEAR PANEL BOUNDARIES	
	Type, size and number of nails per board			
	Common nails	Box nails	Common nails	Box nails
1 × 6	2 - 8d	3 - 8d	3 - 8d	5 - 8d
1 × 8	3 - 8d	4 - 8d	4 - 8d	6 - 8d
2 × 6	2 - 16d	3 - 16d	3 - 16d	5 - 16d
2 × 8	3 - 16d	4 - 16d	4 - 16d	6 - 16d

TABLE 2306.3.1
ALLOWABLE SHEAR (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL DIAPHRAGMS WITH FRAMING OF DOUGLAS FIR-LARCH, OR SOUTHERN PINE[a] FOR WIND LOADING [h]

PANEL GRADE	COMMON NAIL SIZE OR STAPLE[f] LENGTH AND GAGE	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM NOMINAL WIDTH OF FRAMING MEMBERS AT ADJOINING PANEL EDGES AND BOUNDARIES[g] (inches)	BLOCKED DIAPHRAGMS				UNBLOCKED DIAPHRAGMS	
					Fastener spacing (inches) at diaphragm boundaries (all cases) at continuous panel edges parallel to load (Cases 3, 4), and at all panel edges (Cases 5, 6)[b]				Fasteners spaced 6″ max. at supported edges[b]	
					6	4	$2\frac{1}{2}$[c]	2[c]		
					Fastener spacing (inches) at other panel edges (Cases 1, 2, 3 and 4)[b]					
					6	6	4	3	Case 1 (No unblocked edges or continuous joints parallel to load)	All other configurations (Cases 2, 3, 4, 5 and 6)
Structural I Grades	6d[e] (2″ × 0.113″)	$1\frac{1}{4}$	$\frac{5}{16}$	2	185	250	375	420	165	125
				3	210	280	420	475	185	140
	$1\frac{1}{2}$ 16 Gage	1		2	155	205	310	350	135	105
				3	175	230	345	390	155	115
	8d ($2\frac{1}{2}$″ × 0.131)	$1\frac{3}{8}$	$\frac{3}{8}$	2	270	360	530	600	240	180
				3	300	400	600	675	265	200
	$1\frac{1}{2}$ 16 Gage	1		2	175	235	350	400	155	115
				3	200	265	395	450	175	130
	10d[d] (3″ × 0.148″)	$1\frac{1}{2}$	$\frac{15}{32}$	2	320	425	640	730	285	215
				3	360	480	720	820	320	240
	$1\frac{1}{2}$ 16 Gage	1		2	175	235	350	400	155	120
				3	200	265	395	450	175	130
Sheathing, single floor and other grades covered in DOC PS 1 and PS 2	6d[e] (2″ × 0.113)	$1\frac{1}{4}$	$\frac{5}{16}$	2	170	225	335	380	150	110
				3	190	250	380	430	170	125
	$1\frac{1}{2}$ 16 Gage	1		2	140	185	275	315	125	90
				3	155	205	310	350	140	105
	6d[e] (2″ × 0.113)	$1\frac{1}{4}$	$\frac{3}{8}$	2	185	250	375	420	165	125
				3	210	280	420	475	185	140
	8d ($2\frac{1}{2}$″ × 0.131)	$1\frac{3}{8}$		2	240	320	480	545	215	160
				3	270	360	540	610	240	180

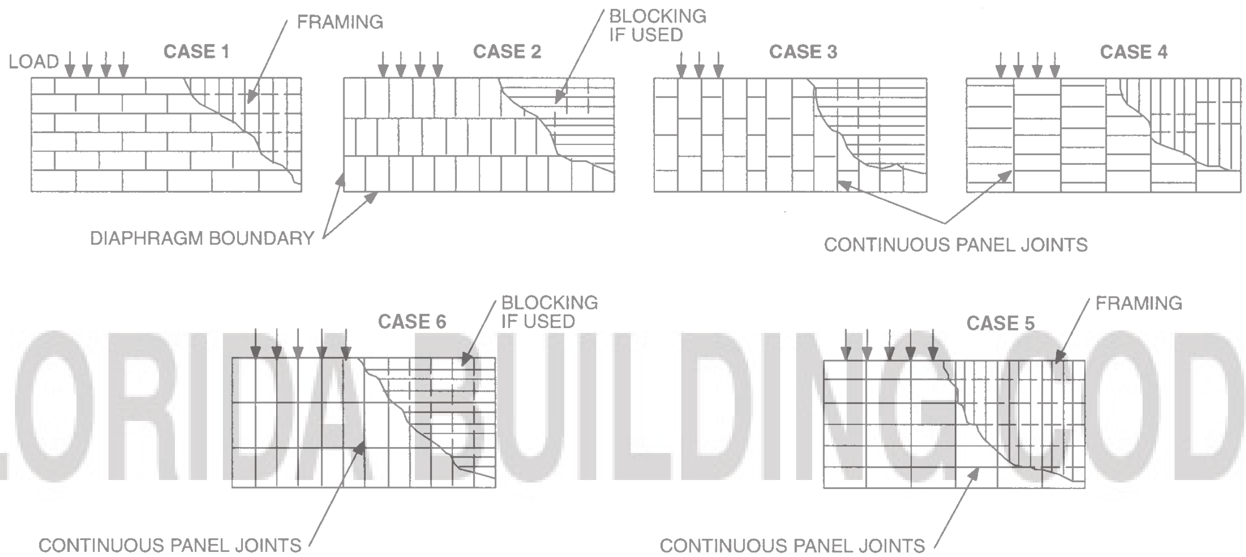
(continued)

TABLE 2306.3.1—continued
ALLOWABLE SHEAR (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL DIAPHRAGMS WITH FRAMING OF DOUGLAS FIR-LARCH, OR SOUTHERN PINE[a] FOR WIND LOADING[h]

PANEL GRADE	COMMON NAIL SIZE OR STAPLE[f] LENGTH AND GAGE	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM NOMINAL WIDTH OF FRAMING MEMBERS AT ADJOINING PANEL EDGES AND BOUNDARIES[g] (inches)	BLOCKED DIAPHRAGMS				UNBLOCKED DIAPHRAGMS	
					Fastener spacing (inches) at diaphragm boundaries (all cases) at continuous panel edges parallel to load (Cases 3, 4), and at all panel edges (Cases 5, 6)[b]				Fasteners spaced 6" max. at supported edges[b]	
					6	4	$2\ ^1/_2$[c]	2[c]		
					Fastener spacing (inches) at other panel edges (Cases 1, 2, 3 and 4)[b]				Case 1 (No unblocked edges or continuous joints parallel to load)	All other configurations (Cases 2, 3, 4, 5 and 6)
					6	6	4	3		
Sheathing, single floor and other grades covered in DOC PS 1 and PS 2 (continued)	$1^1/_2$ 16 Gage	1	$^3/_8$	2	160	210	315	360	140	105
				3	180	235	355	400	160	120
	8d ($2^1/_2$″× 0.131″)	$1\ ^3/_8$	$^7/_{16}$	2	255	340	505	575	230	170
				3	285	380	570	645	255	190
	$1^1/_2$ 16 Gage	1		2	165	225	335	380	150	110
				3	190	250	375	425	165	125
	8d ($2^1/_2$″ × 0.131″)	$1\ ^3/_8$	$^{15}/_{32}$	2	270	360	530	600	240	180
				3	300	400	600	675	265	200
	10d[d] (3″ × 0.148″)	$1\ ^1/_2$		2	290	385	575	655	255	190
				3	325	430	650	735	290	215
	$1^1/_2$ 16 Gage	1	$^{19}/_{32}$	2	160	210	315	360	140	105
				3	180	235	355	405	160	120
	10d[d] (3″ × 0.148″)	$1\ ^1/_2$		2	320	425	640	730	285	215
				3	360	480	720	820	320	240
	$1^3/_4$ 16 Gage	1		2	175	235	350	400	155	115
				3	200	265	395	450	175	130

(continued)

TABLE 2306.3.1—continued
ALLOWABLE SHEAR (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL DIAPHRAGMS WITH FRAMING OF DOUGLAS FIR-LARCH, OR SOUTHERN PINE[a] FOR WIND LOADING[h]



For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

a. For framing of other species: (1) Find specific gravity for species of lumber in AF&PA NDS. (2) For staples find shear value from table above for Structural I panels (regardless of actual grade) and multiply value by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species. (3) For nails find shear value from table above for nail size for actual grade and multiply value by the following adjustment factor: Specific Gravity Adjustment Factor = [1-(0.5 - SG)], where SG = Specific Gravity of the framing lumber. This adjustment factor shall not be greater than 1.
b. Space fasteners maximum 12 inches o.c. along intermediate framing members (6 inches o.c. where supports are spaced 48 inches o.c.).
c. Framing at adjoining panel edges shall be 3 inches nominal or wider, and nails shall be staggered where nails are spaced 2 inches o.c. or 2 $^{1}/_{2}$ inches o.c.
d. Framing at adjoining panel edges shall be 3 inches nominal or wider, and nails shall be staggered where both of the following conditions are met: (1) 10d nails having penetration into framing of more than 1$^{1}/_{2}$ inches and (2) nails are spaced 3 inches o.c. or less.
e. 8d is recommended minimum for roofs due to negative pressures of high winds.
f. Staples shall have a minimum crown width of $^{7}/_{16}$ inch and shall be installed with their crowns parallel to the long dimension of the framing members.
g. The minimum nominal width of framing members not located at boundaries or adjoining panel edges shall be 2 inches.
h. For shear loads of normal or permanent load duration as defined by the AF&PA NDS, the values in the table above shall be multiplied by 0.63 or 0.56, respectively.

TABLE 2306.3.2
ALLOWABLE SHEAR (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL BLOCKED DIAPHRAGMS UTILIZING MULTIPLE ROWS OF FASTENERS (HIGH LOAD DIAPHRAGMS) WITH FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE[a] FOR WIND LOADING[b, g, h]

PANEL GRADE[c]	COMMON NAIL SIZE OR STAPLE[f] GAGE	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM NOMINAL WIDTH OF FRAMING MEMBER AT ADJOINING PANEL EDGES AND BOUNDARIES[e]	LINES OF FASTENERS	BLOCKED DIAPHRAGMS — Cases 1 and 2[d] — Fastener Spacing Per Line at Boundaries (inches): 4		2 1/2		2	
						Fastener Spacing Per Line at Other Panel Edges (inches): 6	4	4	3	3	2
Structural I grades	10d common nails	1 1/2	15/32	3	2	605	815	875	1,150	—	—
				4	2	700	915	1,005	1,290	—	—
				4	3	875	1,220	1,285	1,395	—	—
			19/32	3	2	670	880	965	1,255	—	—
				4	2	780	990	1,110	1,440	—	—
				4	3	965	1,320	1,405	1,790	—	—
			23/32	3	2	730	955	1,050	1,365	—	—
				4	2	855	1,070	1,210	1,565	—	—
				4	3	1,050	1,430	1,525	1,800	—	—
	14 gage staples	2	15/32	3	2	600	600	860	960	1,060	1,200
				4	3	860	900	1,160	1,295	1,295	1,400
			19/32	3	2	600	600	875	960	1,075	1,200
				4	3	875	900	1,175	1,440	1,475	1,795
Sheathing single floor and other grades covered in DOC PS 1 and PS 2	10d common nails	1 1/2	15/32	3	2	525	725	765	1,010	—	—
				4	2	605	815	875	1,105	—	—
				4	3	765	1,085	1,130	1,195	—	—
			19/32	3	2	650	860	935	1,225	—	—
				4	2	755	965	1,080	1,370	—	—
				4	3	935	1,290	1,365	1,485	—	—
			23/32	3	2	710	935	1,020	1,335	—	—
				4	2	825	1,050	1,175	1,445	—	—
				4	3	1,020	1,400	1,480	1,565	—	—
	14 gage staples	2	15/32	3	2	540	540	735	865	915	1,080
				4	3	735	810	1,005	1,105	1,105	1,195
			19/32	3	2	600	600	865	960	1,065	1,200
				4	3	865	900	1,130	1,430	1,370	1,485
			23/32	4	3	865	900	1,130	1,490	1,430	1,545

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

a. For framing of other species: (1) Find specific gravity for species of framing lumber in AF&PA NDS. (2) For staples, find shear value from table above for Structural I panels (regardless of actual grade) and multiply value by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species. (3) For nails, find shear value from table above for nail size of actual grade and multiply value by the following adjustment factor: Specific Gravity Adjustment Factor = [1-(0.5 - SG)], where SG = Specific gravity of the framing lumber. This adjustment factor shall not be greater than 1.

b. Fastening along intermediate framing members: Space fasteners a maximum of 12 inches on center, except 6 inches on center for spans greater than 32 inches.

c. Panels conforming to PS 1 or PS 2.

d. This table gives shear values for Cases 1 and 2 as shown in Table 2306.3.1. The values shown are applicable to Cases 3, 4, 5 and 6 as shown in Table 2306.3.1, providing fasteners at all continuous panel edges are spaced in accordance with the boundary fastener spacing.

e. The minimum nominal depth of framing members shall be 3 inches nominal. The minimum nominal width of framing members not located at boundaries or adjoining panel edges shall be 2 inches.

f. Staples shall have a minimum crown width of $^7/_{16}$ inch, and shall be installed with their crowns parallel to the long dimension of the framing members.

g. High load diaphragms shall be subject to special inspection in accordance with Section 1704.6.1.

h. For shear loads of normal or permanent load duration as defined by the AF&PA NDS, the values in the table above shall be multiplied by 0.63 or 0.56, respectively.

panel design properties given in the *APA Panel Design Specification*.

2306.4.2 Lumber sheathed shear walls. Single and double diagonally sheathed lumber diaphragms are permitted using the construction and allowable load provisions of Sections 2306.3.4 and 2306.3.5.

2306.4.3 Particleboard shear walls. The design shear capacity of particleboard shear walls shall be in accordance with Table 2306.4.3. Shear panels shall be constructed with particleboard sheets not less than 4 feet by 8 feet (1219 mm by 2438 mm), except at boundaries and changes in framing. Particleboard panels shall be designed to resist shear only, and chords, collector members and boundary elements shall be connected at all corners. Panel edges shall be backed with 2-inch (51 mm) nominal or wider framing. Sheets are permitted to be installed either horizontally or vertically. For $^{3}/_{8}$-inch (9.5 mm) particleboard sheets installed with the long dimension parallel to the studs spaced 24 inches (610 mm) o.c, nails shall be spaced at 6 inches (152 mm) o.c. along intermediate framing members. For all other conditions, nails of the same size shall be spaced at 12 inches (305 mm) o.c. along intermediate framing members. Particleboard panels less than 12 inches (305 mm) wide shall be blocked.

2306.4.4 Fiberboard shear walls. The design shear capacity of fiberboard shear walls shall be in accordance with Table 2306.4.4. The fiberboard sheathing shall be applied vertically or horizontally to wood studs not less than 2 inch (51 mm) nominal thickness spaced 16 inches (406 mm) o.c. Blocking not less than 2 inch (51 mm) nominal in thickness shall be provided at horizontal joints.

2306.4.5 Shear walls sheathed with other materials. Shear capacities for walls sheathed with lath and plaster, and gypsum board shall be in accordance with Table 2306.4.5. Shear walls sheathed with lath, plaster and gypsum board shall be constructed in accordance with Chapter 25 and Section 2306.4.5.1.

2306.4.5.1 Application of gypsum board or lath and plaster to wood framing.

2306.4.5.1.1 Joint staggering. End joints of adjacent courses of gypsum board shall not occur over the same stud.

2306.4.5.1.2 Blocking. Where required in Table 2306.4.5, wood blocking having the same cross-sectional dimensions as the studs shall be provided at joints that are perpendicular to the studs.

2306.4.5.1.3 Fastening. Studs, top and bottom plates and blocking shall be fastened in accordance with Table 2304.9.1.

2306.4.5.1.4 Fasteners. The size and spacing of fasteners shall be set forth in Table 2306.4.5. Fasteners shall be spaced not less than $^{3}/_{8}$ inch (9.5 mm) from edges and ends of gypsum boards or sides of studs, blocking and top and bottom plates.

2306.4.5.1.5 Gypsum lath. Gypsum lath shall be applied perpendicular to the studs. Maximum allowable shear values shall be as set forth in Table 2306.4.5.

2306.4.5.1.6 Gypsum sheathing. Four-foot-wide (1219 mm) pieces of gypsum sheathing shall be applied parallel or perpendicular to studs. Two-foot-wide (610 mm) pieces of gypsum sheathing shall be applied perpendicular to the studs. Maximum allowable shear values shall be as set forth in Table 2306.4.5.

2306.4.5.1.7 Other gypsum boards. Gypsum board shall be applied parallel or perpendicular to studs. Maximum allowable shear values shall be as set forth in Table 2306.4.5.

SECTION 2307
LOAD AND RESISTANCE FACTOR DESIGN

2307.1 Load and resistance factor design. The structural analysis and construction of wood elements and structures using load and resistance factor design shall be in accordance with AF&PA NDS.

2307.1.1 Wood structural panel shear walls. Reserved.

SECTION 2308
CONVENTIONAL LIGHT-FRAME CONSTRUCTION

2308.1 General. The requirements of this section are intended for conventional light-frame construction. Other methods are permitted to be used, provided a satisfactory design is submitted showing compliance with other provisions of this code. Interior nonload-bearing partitions, ceilings and curtain walls of conventional light-frame construction are not subject to the limitations of this section. Alternatively, compliance with AF&PA WFCM shall be permitted subject to the limitations therein and the limitations of this code. Detached one- and two-family dwellings and multiple single-family dwellings (townhouses) not more than three stories above grade plane in height with a separate means of egress and their accessory structures shall comply with the *Florida Building Code, Residential*.

2308.1.1 Portions exceeding limitations of conventional construction. When portions of a building of otherwise conventional construction exceed the limits of Section 2308.2, these portions and the supporting load path shall be designed in accordance with accepted engineering practice and the provisions of this code. For the purposes of this section, the term "portions" shall mean parts of buildings containing volume and area such as a room or a series of rooms.

2308.2 Limitations. Buildings are permitted to be constructed in accordance with the provisions of conventional light-frame construction, subject to the following limitations, and to further limitations of Sections 2308.11 and 2308.12.

TABLE 2306.4.1
ALLOWABLE SHEAR (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL SHEAR WALLS WITH FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE[a] FOR WIND LOADING[b, h, i, j, l]

PANEL GRADE	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	PANELS APPLIED DIRECT TO FRAMING					PANELS APPLIED OVER $^{1}/_{2}$″ OR $^{5}/_{8}$″ GYPSUM SHEATHING				
			NAIL (common or galvanized box) or staple size[k]	Fastener spacing at panel edges (inches)				NAIL (common or galvanized box) or staple size[k]	Fastener spacing at panel edges (inches)			
				6	4	3	2[e]		6	4	3	2[e]
Structural I Sheathing	$^{5}/_{16}$	$1^{1}/_{4}$	6d (2 × 0.113″ common, 2″ × 0.099″ galvanized box)	200	300	390	510	8d ($2^{1}/_{2}$″ × 0.131″ common, $2^{1}/_{2}$″ × 0.113″ galvanized box)	200	300	390	510
		1	$1^{1}/_{2}$ 16 Gage	165	245	325	415	2 16 Gage	125	185	245	315
	$^{3}/_{8}$	$1^{3}/_{8}$	8d ($2^{1}/_{2}$″ × 0.131″ common, $2^{1}/_{2}$″ × 0.113″ galvanized box)	230[d]	360[d]	460[d]	610[d]	10d (3″ × 0.148″ common, 3″ × 0.128″ galvanized box)	280	430	550[f]	730
		1	$1^{1}/_{2}$ 16 Gage	155	235	315	400	2 16 Gage	155	235	310	400
	$^{7}/_{16}$	$1^{3}/_{8}$	8d ($2^{1}/_{2}$″ × 0.131″ common, $2^{1}/_{2}$″ × 0.113″ galvanized box)	255[d]	395[d]	505[d]	670[d]	10d (3″ × 0.148″ common, 3″ × 0.128″ galvanized box)	280	430	550[f]	730
		1	$1^{1}/_{2}$ 16 Gage	170	260	345	440	2 16 Gage	155	235	310	400
	$^{15}/_{32}$	$1^{3}/_{8}$	8d ($2^{1}/_{2}$″ × 0.131″ common, $2^{1}/_{2}$″ × 0.113″ galvanized box)	280	430	550	730	10d (3″ × 0.148″ common, 3″ × 0.1218″ galvanized box)	280	430	550[f]	730
		1	$1^{1}/_{2}$ 16 Gage	185	280	375	475	2 16 Gage	155	235	300	400
		$1^{1}/_{2}$	10d (3″ × 0.148″ common, 3″ × 0.128″ galvanized box)	340	510	665[f]	870	10d (3″ × 0.148″ common, 3″ × 0.128″ galvanized box)	—	—	—	—
Sheathing, plywood siding[g] except Group 5 Species	$^{5}/_{16}$ or $^{1}/_{4}$[c]	$1^{1}/_{4}$	6d (2″ × 0.113″ common, 2″ × 0.099″ galvanized box)	180	270	350	450	8d ($2^{1}/_{2}$″ × 0.131″ common, $2^{1}/_{2}$″ × 0.113″ galvanized box)	180	270	350	450
		1	$1^{1}/_{2}$ 16 Gage	145	220	295	375	2 16 Gage	110	165	220	285
	$^{3}/_{8}$	$1^{1}/_{4}$	6d (2″ × 0.113″ common, 2″ × 0.099″ galvanized box)	200	300	390	510	8d ($2^{1}/_{2}$″ × 0.131″ common, $2^{1}/_{2}$″ × 0.113″ galvanized box)	200	300	390	510
		$1^{3}/_{8}$	8d ($2^{1}/_{2}$″ × 0.131″ common, $2^{1}/_{2}$″ × 0.113″ galvanized box)	220[d]	320[d]	410[d]	530[d]	10d (3″ × 0.148″ common, 3″ × 0.128″ galvanized box)	260	380	490[f]	640
		1	$1^{1}/_{2}$ 16 Gage	140	210	280	360	2 16 Gage	140	210	280	360
	$^{7}/_{16}$	$1^{3}/_{8}$	8d ($2^{1}/_{2}$″ × 0.131″ common, $2^{1}/_{2}$″ × 0.113″ galvanized box)	240[d]	350[d]	450[d]	585[d]	10d (3″ × 0.148″ common, 3″ × 0.128″ galvanized box)	260	380	490[f]	640
		1	$1^{1}/_{2}$ 16 Gage	155	230	310	395	2 16 Gage	140	210	280	360
	$^{15}/_{32}$	$1^{3}/_{8}$	8d ($2^{1}/_{2}$″ × 0.131″ common, $2^{1}/_{2}$″ × 0.113″ galvanized box)	260	380	490	640	10d (3″ × 0.148″ common, 3″ × 0.128″ galvanized box)	260	380	490[f]	640
		$1^{1}/_{2}$	10d (3″ × 0.148″ common, 3″ × 0.128” galvanized box)	310	460	600[f]	770	—	—	—	—	—
		1	$1^{1}/_{2}$ 16 Gage	170	255	335	430	2 16 Gage	140	210	280	360
	$^{19}/_{32}$	$1^{1}/_{2}$	10d (3″ × 0.148″ common, 3″ × 0.128″ galvanized box)	340	510	665[f]	870	—	—	—	—	—
		1	$1^{3}/_{4}$ 16 Gage	185	280	375	475	—	—	—	—	—
			Nail Size (galvanized casing)					Nail Size (galvanized casing)				
	$^{5}/_{16}$[c]	$1^{1}/_{4}$	6d (2″ × 0.099″)	140	210	275	360	8d ($2^{1}/_{2}$″ × 0.113″)	140	210	275	360
	$^{3}/_{8}$	$1^{3}/_{8}$	8d ($2^{1}/_{2}$″ × 0.113″)	160	240	310	410	10d (3″ × 0.128″)	160	240	310[f]	410

(continued)

Notes to Table 2306.4.1

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

a. For framing of other species: (1) Find specific gravity for species of lumber in AF&PA NDS. (2) For staples find shear value from table above for Structural I panels (regardless of actual grade) and multiply value by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species. (3) For nails find shear value from table above for nail size for actual grade and multiply value by the following adjustment factor: Specific Gravity Adjustment Factor = [1-(0.5 - SG)], where SG = Specific Gravity of the framing lumber. This adjustment factor shall not be greater than 1.
b. Panel edges backed with 2-inch nominal or wider framing. Install panels either horizontally or vertically. Space fasteners maximum 6 inches on center along intermediate framing members for 3/8-inch and 7/16-inch panels installed on studs spaced 24 inches on center. For other conditions and panel thickness, space fasteners maximum 12 inches on center on intermediate supports.
c. 3/8-inch panel thickness or siding with a span rating of 16 inches on center is the minimum recommended where applied direct to framing as exterior siding.
d. Allowable shear values are permitted to be increased to values shown for 15/32-inch sheathing with same nailing provided (a) studs are spaced a maximum of 16 inches on center, or (b) panels are applied with long dimension across studs.
e. Framing at adjoining panel edges shall be 3 inches nominal or wider, and nails shall be staggered where nails are spaced 2 inches on center.
f. Framing at adjoining panel edges shall be 3 inches nominal or wider, and nails shall be staggered where both of the following conditions are met: (1) 10d (3″ × 0.148″) nails having penetration into framing of more than 1 1/2 inches and (2) nails are spaced 3 inches on center.
g. Values apply to all-veneer plywood. Thickness at point of fastening on panel edges governs shear values.
h. Where panels applied on both faces of a wall and nail spacing is less than 6 inches o.c. on either side, panel joints shall be offset to fall on different framing members, or framing shall be 3-inch nominal or thicker at adjoining panel edges and nails on each side shall be staggered.
i. Reserved.
j. Galvanized nails shall be hot dipped or tumbled.
k. Staples shall have a minimum crown width of 7/16 inch and shall be installed with their crowns parallel to the long dimension of the framing members.
l. For shear loads of normal or permanent load duration as defined by the AF&PA NDS, the values in the table above shall be multiplied by 0.63 or 0.56, respectively.

TABLE 2306.4.3
ALLOWABLE SHEAR FOR PARTICLEBOARD SHEAR WALL SHEATHING[b]

PANEL GRADE	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM NAIL PENETRATION IN FRAMING (inches)	PANELS APPLIED DIRECT TO FRAMING				
			Nail size (common or galvanized box)	Allowable shear (pounds per foot) nail spacing at panel edges (inches)[a]			
				6	4	3	2
M-S "Exterior Glue" and M-2 "Exterior Glue"	3/8	1 1/2	6d	120	180	230	300
	3/8	1 1/2	8d	130	190	240	315
	1/2			140	210	270	350
	1/2	1 5/8	10d	185	275	360	460
	5/8			200	305	395	520

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.
a. Values are not permitted in Seismic Design Category D, E or F.
b. Galvanized nails shall be hot-dipped or tumbled.

TABLE 2306.4.4
ALLOWABLE SHEAR VALUES (plf) FOR WIND LOADING ON SHEAR WALLS OF FIBERBOARD SHEATHING BOARD CONSTRUCTION FOR TYPE V CONSTRUCTION ONLY[a,b,c,d,e,f,g,h]

THICKNESS AND GRADE	FASTENER SIZE	SHEAR VALUE (pounds per linear foot) 3-INCH NAIL SPACING AROUND PERIMETER AND 6-INCH AT INTERMEDIATE POINTS
1/2″ Structural	No. 11 gage galvanized roofing nail 1 1/2″ long, 7/16″ head	125[g]
25/32″ Structural	No. 11 gage galvanized roofing nail 1 3/4″ long, 7/16″ head	175[g]

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.
a. Fiberboard sheathing diaphragms shall not be used to brace concrete or masonry walls.
b. Panel edges shall be backed with 2 inch or wider framing of Douglas fir-larch or Southern pine.
c. Fiberboard sheathing on one side only.
d. Fiberboard panels are installed with their long dimension parallel or perpendicular to studs.
e. Fasteners shall be spaced 6 inches on center along intermediate framing members.
f. For framing of other species: (1) Find specific gravity for species of lumber in AF&PA NDS and (2) Multiply the shear value from the above table by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species.
g. The same values can be applied when staples are used as described in Table 2304.9.1.
h. Reserved.

TABLE 2306.4.5
ALLOWABLE SHEAR FOR WIND FORCES FOR SHEAR WALLS OF LATH AND PLASTER OR GYPSUM BOARD WOOD FRAMED WALL ASSEMBLIES

TYPE OF MATERIAL	THICKNESS OF MATERIAL	WALL CONSTRUCTION	FASTENER SPACING[b] MAXIMUM (inches)	SHEAR VALUE[a,e] (plf)	MINIMUM FASTENER SIZE[c,d,j,k]
1. Expanded metal or woven wire lath and portland cement plaster	7/8″	Unblocked	6	180	No. 11 gage 1 1/2″ long, 7/16″ head 16 Ga. Galv. Staple, 7/8″ legs
2. Gypsum lath, plain or perforated	3/8″ lath and 1/2″ plaster	Unblocked	5	100	No. 13 gage, 1 1/8″ long, 19/64″ head, plasterboard nail 16 Ga. Galv. Staple, 1 1/8″ long 0.120″ Nail, min. 3/8″ head, 1 1/4″ long
3. Gypsum sheathing	1/2″ × 2′ × 8′	Unblocked	4	75	No. 11 gage, 1 3/4″ long, 7/16″ head, diamond-point, galvanized 16 Ga. Galv. Staple, 1 3/4″ long
	1/2″ × 4′	Blocked[f] Unblocked	4 7	175 100	
	5/8″ × 4′	Blocked	4″ edge/ 7″ field	200	6d galvanized 0.120″ Nail, min. 3/8″ head, 1 3/4″ long
4. Gypsum board, gypsum veneer base or water-resistant gypsum backing board	1/2″	Unblocked[f]	7	75	5d cooler (1 5/8″ x .086″) or wallboard 0.120″ nail, min. 3/8 ″ head, 1 1/2 ″ long 16 Gage Staple, 1 1/2″ long
		Unblocked[f]	4	110	
		Unblocked	7	100	
		Unblocked	4	125	
		Blocked[g]	7	125	
		Blocked[g]	4	150	
		Unblocked	8/12[h]	60	No. 6 1 1/4″ screws[i]
		Blocked[g]	4/16[h]	160	
		Blocked[g]	4/12[h]	155	
		Blocked[f, g]	8/12[h]	70	
		Blocked[g]	6/12[h]	90	
	5/8″	Unblocked[f]	7	115	6d cooler (1 7/8″ x 0.092″) or wallboard 0.120″ Nail, min. 3/8″ head, 1 3/4″ long 16 Gage Staple, 1 1/2″ legs, 1 5/8″ long
		Unblocked[f]	4	145	
		Blocked[g]	7	145	
		Blocked[g]	4	175	
		Blocked[g] Two-ply	Base ply: 9 Face ply: 7	250	Base ply-6d cooler (1 7/8″ × 0.092″) or wallboard 1 3/4″ x 0.120″ Nail, min. 3/8″ head 1 5/8″ 16 Ga. Galv. Staple 1 5/8″ 16 Gage Galv. Staple Face ply-8d cooler (2 3/8″ × 0.113″) or wallboard 0.120″ Nail, min. 3/8″ head, 2 3/8″ long 15 Ga. Galv. Staple, 2 1/4″ long
		Unblocked	8/12[h]	70	No. 6-1 1/4″ screws[i]
		Blocked[g]	8/12[h]	90	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per foot = 14.5939 N/m.

a. These shear walls shall not be used to resist loads imposed by masonry or concrete construction (see Section 2305.1.5). Values shown are for short-term loading due to wind loading. Values shown shall be reduced 25 percent for normal loading.
b. Applies to fastening at studs, top and bottom plates and blocking.
c. Alternate fasteners are permitted to be used if their dimensions are not less than the specified dimensions. Drywall screws are permitted to substitute for the 5d (1 5/8″ × 0.086″), and 6d (1 7/8″ × 0.092″)(cooler) nails listed above, and No. 6 1 1/4 inch Type S or W screws for 6d (1 7/8″ × 0.092) (cooler) nails.
d. For properties of cooler nails, see ASTM C 514.
e. Except as noted, shear values are based on a maximum framing spacing of 16 inches on center.
f. Maximum framing spacing of 24 inches on center.
g. All edges are blocked, and edge fastening is provided at all supports and all panel edges.
h. First number denotes fastener spacing at the edges; second number denotes fastener spacing at intermediate framing members.
i. Screws are Type W or S.
j. Staples shall have a minimum crown width of 7/16 inch, measured outside the legs, and shall be installed with their crowns parallel to the long dimension of the framing members.
k. Staples for the attachment of gypsum lath and woven-wire lath shall have a minimum crown width of 3/4 inch, measured outside the legs.

1. Buildings shall be limited to a maximum of three stories above grade.
2. Maximum floor-to-floor height shall not exceed 11 feet 7 inches (3529 mm). Bearing wall height shall not exceed a stud height of 10 feet (3048 mm).
3. Loads as determined in Chapter 16 shall not exceed the following:
   3.1. Average dead loads shall not exceed 15 psf (718 N/m^2) for combined roof and ceiling, exterior walls, floors and partitions.

   Exceptions:

   1. Subject to the limitations of Sections 2308.11.2 and 2308.12.2, stone or masonry veneer up to the lesser of 5 inches (127 mm) thick or 50 psf (2395 N/m^2) and installed in accordance with Chapter 14 is permitted to a height of 30 feet (9144 mm) above a noncombustible foundation, with an additional 8 feet (2438 mm) permitted for gable ends.
   2. Concrete or masonry fireplaces, heaters and chimneys shall be permitted in accordance with the provisions of this code.

   3.2. Live loads shall not exceed 40 psf (1916 N/m^2) for floors.
4. Wind speeds shall not exceed 100 miles per hour (mph) (44 m/s) (3-second gust).
5. Roof trusses and rafters shall not span more than 40 feet (12 192 mm) between points of vertical support.
6. Reserved.
7. Reserved.

2308.2.1 Basic wind speed greater than 100 mph (3-second gust). Where the basic wind speed exceeds 100 mph (3-second gust), the provisions of either the AF&PA *Wood Frame Construction Manual for One- and Two-Family Dwellings* (WFCM) or the IBHS *Guideline for Hurricane Resistant Residential Construction*, are permitted to be used.

2308.2.2 Buildings in Seismic Design Category B, C, D or E. Reserved.

2308.3 Braced wall lines. Buildings shall be provided with exterior and interior braced wall lines as described in Section 2308.9.3 and installed in accordance with Sections 2308.3.1 through 2308.3.4.

2308.3.1 Spacing. Spacing of braced wall lines shall not exceed 35 feet (10 668 mm) o.c. in both the longitudinal and transverse directions in each story.

2308.3.2 Braced wall panel connections. Forces shall be transferred from the roofs and floors to braced wall panels and from the braced wall panels in upper stories to the braced wall panels in the story below by the following:

1. Braced wall panel top and bottom plates shall be fastened to joists, rafters or full-depth blocking. Braced wall panels shall be extended and fastened to roof framing at intervals not to exceed 50 feet (15 240 mm) between parallel braced wall lines.

   Exception: Where roof trusses are used, lateral forces shall be transferred from the roof diaphragm to the braced wall by blocking of the ends of the trusses or by other approved methods.
2. Bottom plate fastening to joist or blocking below shall be with not less than 3-16d nails at 16 inches (406 mm) o.c.
3. Blocking shall be nailed to the top plate below with not less than 3-8d toenails per block.
4. Joists parallel to the top plates shall be nailed to the top plate with not less than 8d toenails at 6 inches (152 mm) o.c.

In addition, top plate laps shall be nailed with not less than 8-16d face nails on each side of each break in the top plate.

2308.3.3 Sill anchorage. Where foundations are required by Section 2308.3.4, braced wall line sills shall be anchored to concrete or masonry foundations. Such anchorage shall conform to the requirements of Section 2308.6 except that such anchors shall be spaced at not more than 4 feet (1219 mm) o.c. for structures over two stories in height. The anchors shall be distributed along the length of the braced wall line. Other anchorage devices having equivalent capacity are permitted.

2308.3.3.1 Anchorage to all-wood foundations. Where all-wood foundations are used, the force transfer from the braced wall lines shall be determined based on calculation and shall have a capacity greater than or equal to the connections required by Section 2308.3.3.

2308.3.4 Braced wall line support. Braced wall lines shall be supported by continuous foundations.

Exception: For structures with a maximum plan dimension not over 50 feet (15 240 mm), continuous foundations are required at exterior walls only.

2308.4 Design of elements. Combining of engineered elements or systems and conventionally specified elements or systems is permitted subject to the following limits:

2308.4.1 Elements exceeding limitations of conventional construction. When a building of otherwise conventional construction contains structural elements exceeding the limits of Section 2308.2, these elements and the supporting load path shall be designed in accordance with accepted engineering practice and the provisions of this code.

2308.4.2 Structural elements or systems not described herein. When a building of otherwise conventional construction contains structural elements or systems not described in Section 2308, these elements or systems shall be designed in accordance with accepted engineering practice and the provisions of this code. The extent of such design need only demonstrate compliance of the nonconventional elements with other applicable provisions of this code and shall be compatible with the performance of the conventionally framed system.

2308.5 Connections and fasteners. Connections and fasteners used in conventional construction shall comply with the requirements of Section 2304.9.

2308.6 Foundation plates or sills. Foundations and footings shall be as specified in Chapter 18. Foundation plates or sills resting on concrete or masonry foundations shall comply with Section 2304.3.1. Foundation plates or sills shall be bolted or anchored to the foundation with not less than $^1/_2$-inch-diameter (12.7 mm) steel bolts or approved anchors spaced to provide equivalent anchorage as the steel bolts. Bolts shall be embedded at least 7 inches (178 mm) into concrete or masonry, and spaced not more than 6 feet (1829 mm) apart. There shall be a minimum of two bolts or anchor straps per piece with one bolt or anchor strap located not more than 12 inches (305 mm) or less than 4 inches (102 mm) from each end of each piece. A properly sized nut and washer shall be tightened on each bolt to the plate.

2308.7 Girders. Girders for single-story construction or girders supporting loads from a single floor shall not be less than 4 inches by 6 inches (102 mm by 152 mm) for spans 6 feet (1829 mm) or less, provided that girders are spaced not more than 8 feet (2438 mm) o.c. Spans for built-up 2-inch (51 mm) girders shall be in accordance with Table 2308.9.5 or 2308.9.6. Other girders shall be designed to support the loads specified in this code. Girder end joints shall occur over supports.

Where a girder is spliced over a support, an adequate tie shall be provided. The ends of beams or girders supported on masonry or concrete shall not have less than 3 inches (76 mm) of bearing.

2308.8 Floor joists. Spans for floor joists shall be in accordance with Table 2308.8(1) or 2308.8(2). For other grades and or species, refer to the *AF&PA Span Tables for Joists and Rafters*.

2308.8.1 Bearing. Except where supported on a 1-inch by 4-inch (25.4 mm by 102 mm) ribbon strip and nailed to the adjoining stud, the ends of each joist shall not have less than $1^1/_2$ inches (38 mm) of bearing on wood or metal, or less than 3 inches (76 mm) on masonry.

2308.8.2 Framing details. Joists shall be supported laterally at the ends and at each support by solid blocking except where the ends of the joists are nailed to a header, band or rim joist or to an adjoining stud or by other means. Solid blocking shall not be less than 2 inches (51mm) in thickness and the full depth of the joist. Notches on the ends of joists shall not exceed one-fourth the joist depth. Holes bored in joists shall not be within 2 inches (51 mm) of the top or bottom of the joist, and the diameter of any such hole shall not exceed one-third the depth of the joist. Notches in the top or bottom of joists shall not exceed one-sixth the depth and shall not be located in the middle third of the span.

Joist framing from opposite sides of a beam, girder or partition shall be lapped at least 3 inches (76 mm) or the opposing joists shall be tied together in an approved manner.

Joists framing into the side of a wood girder shall be supported by framing anchors or on ledger strips not less than 2 inches by 2 inches (51 mm by 51 mm).

2308.8.2.1 Engineered wood products. Cuts, notches and holes bored in trusses, structural composite lumber, structural glue-laminated members or I-joists are not permitted except where permitted by the manufacturer's recommendations or where the effects of such alterations are specifically considered in the design of the member by a registered design professional.

2308.8.3 Framing around openings. Trimmer and header joists shall be doubled, or of lumber of equivalent cross section, where the span of the header exceeds 4 feet (1219 mm). The ends of header joists more than 6 feet (1829 mm) long shall be supported by framing anchors or joist hangers unless bearing on a beam, partition or wall. Tail joists over 12 feet (3658 mm) long shall be supported at the header by framing anchors or on ledger strips not less than 2 inches by 2 inches (51 mm by 51 mm).

2308.8.4 Supporting bearing partitions. Bearing partitions parallel to joists shall be supported on beams, girders, doubled joists, walls or other bearing partitions. Bearing partitions perpendicular to joists shall not be offset from supporting girders, walls or partitions more than the joist depth unless such joists are of sufficient size to carry the additional load.

2308.8.5 Lateral support. Floor, attic and roof framing with a nominal depth-to-thickness ratio greater than or equal to 5:1 shall have one edge held in line for the entire span. Where the nominal depth-to-thickness ratio of the framing member exceeds 6:1, there shall be one line of bridging for each 8 feet (2438 mm) of span, unless both edges of the member are held in line. The bridging shall consist of not less than 1-inch by 3-inch (25 mm by 76 mm) lumber, double nailed at each end, of equivalent metal bracing of equal rigidity, full-depth solid blocking or other approved means. A line of bridging shall also be required at supports where equivalent lateral support is not otherwise provided.

2308.8.6 Structural floor sheathing. Structural floor sheathing shall comply with the provisions of Section 2304.7.1.

2308.8.7 Under-floor ventilation. For under-floor ventilation, see Section 1203.3.

2308.9 Wall framing.

2308.9.1 Size, height and spacing. The size, height and spacing of studs shall be in accordance with Table 2308.9.1 except that utility-grade studs shall not be spaced more than 16 inches (406 mm) o.c., or support more than a roof and ceiling, or exceed 8 feet (2438 mm) in height for exterior walls and load-bearing walls or 10 feet (3048 mm) for interior nonload-bearing walls.

TABLE 2308.8(1)
FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES
(Residential Sleeping Areas, Live Load = 30 psf, L/Δ = 360)

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2x6	2x8	2x10	2x12	2x6	2x8	2x10	2x12
			Maximum floor joist spans							
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	12-6	16-6	21-0	25-7	12-6	16-6	21-0	25-7
	Douglas Fir-Larch	#1	12-0	15-10	20-3	24-8	12-0	15-7	19-0	22-0
	Douglas Fir-Larch	#2	11-10	15-7	19-10	23-0	11-6	14-7	17-9	20-7
	Douglas Fir-Larch	#3	9-8	12-4	15-0	17-5	8-8	11-0	13-5	15-7
	Hem-Fir	SS	11-10	15-7	19-10	24-2	11-10	15-7	19-10	24-2
	Hem-Fir	#1	11-7	15-3	19-5	23-7	11-7	15-2	18-6	21-6
	Hem-Fir	#2	11-0	14-6	18-6	22-6	11-0	14-4	17-6	20-4
	Hem-Fir	#3	9-8	12-4	15-0	17-5	8-8	11-0	13-5	15-7
	Southern Pine	SS	12-3	16-2	20-8	25-1	12-3	16-2	20-8	25-1
	Southern Pine	#1	12-0	15-10	20-3	24-8	12-0	15-10	20-3	24-8
	Southern Pine	#2	11-10	15-7	19-10	24-2	11-10	15-7	18-7	21-9
	Southern Pine	#3	10-5	13-3	15-8	18-8	9-4	11-11	14-0	16-8
	Spruce-Pine-Fir	SS	11-7	15-3	19-5	23-7	11-7	15-3	19-5	23-7
	Spruce-Pine-Fir	#1	11-3	14-11	19-0	23-0	11-3	14-7	17-9	20-7
	Spruce-Pine-Fir	#2	11-3	14-11	19-0	23-0	11-3	14-7	17-9	20-7
	Spruce-Pine-Fir	#3	9-8	12-4	15-0	17-5	8-8	11-0	13-5	15-7
16	Douglas Fir-Larch	SS	11-4	15-0	19-1	23-3	11-4	15-0	19-1	23-0
	Douglas Fir-Larch	#1	10-11	14-5	18-5	21-4	10-8	13-6	16-5	19-1
	Douglas Fir-Larch	#2	10-9	14-1	17-2	19-11	9-11	12-7	15-5	17-10
	Douglas Fir-Larch	#3	8-5	10-8	13-0	15-1	7-6	9-6	11-8	13-6
	Hem-Fir	SS	10-9	14-2	18-0	21-11	10-9	14-2	18-0	21-11
	Hem-Fir	#1	10-6	13-10	17-8	20-9	10-4	13-1	16-0	18-7
	Hem-Fir	#2	10-0	13-2	16-10	19-8	9-10	12-5	15-2	17-7
	Hem-Fir	#3	8-5	10-8	13-0	15-1	7-6	9-6	11-8	13-6
	Southern Pine	SS	11-2	14-8	18-9	22-10	11-2	14-8	18-9	22-10
	Southern Pine	#1	10-11	14-5	18-5	22-5	10-11	14-5	17-11	21-4
	Southern Pine	#2	10-9	14-2	18-0	21-1	10-5	13-6	16-1	18-10
	Southern Pine	#3	9-0	11-6	13-7	16-2	8-1	10-3	12-2	14-6
	Spruce-Pine-Fir	SS	10-6	13-10	17-8	21-6	10-6	13-10	17-8	21-4
	Spruce-Pine-Fir	#1	10-3	13-6	17-2	19-11	9-11	12-7	15-5	17-10
	Spruce-Pine-Fir	#2	10-3	13-6	17-2	19-11	9-11	12-7	15-5	17-10
	Spruce-Pine-Fir	#3	8-5	10-8	13-0	15-1	7-6	9-6	11-8	13-6

(continued)

TABLE 2308.8(1)—continued
FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES
(Residential Sleeping Areas, Live Load = 30 psf, L/Δ = 360)

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2x6	2x8	2x10	2x12	2x6	2x8	2x10	2x12
			Maximum floor joist spans							
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas Fir-Larch	SS	10-8	14-1	18-0	21-10	10-8	14-1	18-0	21-0
	Douglas Fir-Larch	#1	10-4	13-7	16-9	19-6	9-8	12-4	15-0	17-5
	Douglas Fir-Larch	#2	10-1	12-10	15-8	18-3	9-1	11-6	14-1	16-3
	Douglas Fir-Larch	#3	7-8	9-9	11-10	13-9	6-10	8-8	10-7	12-4
	Hem-Fir	SS	10-1	13-4	17-0	20-8	10-1	13-4	17-0	20-7
	Hem-Fir	#1	9-10	13-0	16-4	19-0	9-6	12-0	14-8	17-0
	Hem-Fir	#2	9-5	12-5	15-6	17-1	8-11	11-4	13-10	16-1
	Hem-Fir	#3	7-8	9-9	11-10	13-9	6-10	8-8	10-7	12-4
	Southern Pine	SS	10-6	13-10	17-8	21-6	10-6	13-10	17-8	21-6
	Southern Pine	#1	10-4	13-7	17-4	21-1	10-4	13-7	16-4	19-6
	Southern Pine	#2	10-1	13-4	16-5	19-3	9-6	12-4	14-8	17-2
	Southern Pine	#3	8-3	10-6	12-5	14-9	7-4	9-5	11-1	13-2
	Spruce-Pine-Fir	SS	9-10	13-0	16-7	20-2	9-10	13-0	16-7	19-6
	Spruce-Pine-Fir	#1	9-8	12-9	15-8	18-3	9-1	11-6	14-1	16-3
	Spruce-Pine-Fir	#2	9-8	12-9	15-8	18-3	9-1	11-6	14-1	16-3
	Spruce-Pine-Fir	#3	7-8	9-9	11-10	13-9	6-10	8-8	10-7	12-4
24	Douglas Fir-Larch	SS	9-11	13-1	16-8	20-3	9-11	13-1	16-2	18-9
	Douglas Fir-Larch	#1	9-7	12-4	15-0	17-5	8-8	11-0	13-5	15-7
	Douglas Fir-Larch	#2	9-1	11-6	14-1	16-3	8-1	10-3	12-7	14-7
	Douglas Fir-Larch	#3	6-10	8-8	10-7	12-4	6-2	7-9	9-6	11-0
	Hem-Fir	SS	9-4	12-4	15-9	19-2	9-4	12-4	15-9	18-5
	Hem-Fir	#1	9-2	12-0	14-8	17-0	8-6	10-9	13-1	15-2
	Hem-Fir	#2	8-9	11-4	13-10	16-1	8-0	10-2	12-5	14-4
	Hem-Fir	#3	6-10	8-8	10-7	12-4	6-2	7-9	9-6	11-0
	Southern Pine	SS	9-9	12-10	16-5	19-11	9-9	12-10	16-5	19-11
	Southern Pine	#1	9-7	12-7	16-1	19-6	9-7	12-4	14-7	17-5
	Southern Pine	#2	9-4	12-4	14-8	17-2	8-6	11-0	13-1	15-5
	Southern Pine	#3	7-4	9-5	11-1	13-2	6-7	8-5	9-11	11-10
	Spruce-Pine-Fir	SS	9-2	12-1	15-5	18-9	9-2	12-1	15-0	17-5
	Spruce-Pine-Fir	#1	8-11	11-6	14-1	16-3	8-1	10-3	12-7	14-7
	Spruce-Pine-Fir	#2	8-11	11-6	14-1	16-3	8-1	10-3	12-7	14-7
	Spruce-Pine-Fir	#3	6-10	8-8	10-7	12-4	6-2	7-9	9-6	11-0

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.8 N/m^2.

TABLE 2308.8(2)
FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES
(Residential Living Areas, Live Load = 40 psf, L/Δ = 360)

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2x6	2x8	2x10	2x12	2x6	2x8	2x10	2x12
			Maximum floor joist spans							
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	11-4	15-0	19-1	23-3	11-4	15-0	19-1	23-3
	Douglas Fir-Larch	#1	10-11	14-5	18-5	22-0	10-11	14-2	17-4	20-1
	Douglas Fir-Larch	#2	10-9	14-2	17-9	20-7	10-6	13-3	16-3	18-10
	Douglas Fir-Larch	#3	8-8	11-0	13-5	15-7	7-11	10-0	12-3	14-3
	Hem-Fir	SS	10-9	14-2	18-0	21-11	10-9	14-2	18-0	21-11
	Hem-Fir	#1	10-6	13-10	17-8	21-6	10-6	13-10	16-11	19-7
	Hem-Fir	#2	10-0	13-2	16-10	20-4	10-0	13-1	16-0	18-6
	Hem-Fir	#3	8-8	11-0	13-5	15-7	7-11	10-0	12-3	14-3
	Southern Pine	SS	11-2	14-8	18-9	22-10	11-2	14-8	18-9	22-10
	Southern Pine	#1	10-11	14-5	18-5	22-5	10-11	14-5	18-5	22-5
	Southern Pine	#2	10-9	14-2	18-0	21-9	10-9	14-2	16-11	19-10
	Southern Pine	#3	9-4	11-11	14-0	16-8	8-6	10-10	12-10	15-3
	Spruce-Pine-Fir	SS	10-6	13-10	17-8	21-6	10-6	13-10	17-8	21-6
	Spruce-Pine-Fir	#1	10-3	13-6	17-3	20-7	10-3	13-3	16-3	18-10
	Spruce-Pine-Fir	#2	10-3	13-6	17-3	20-7	10-3	13-3	16-3	18-10
	Spruce-Pine-Fir	#3	8-8	11-0	13-5	15-7	7-11	10-0	12-3	14-3
16	Douglas Fir-Larch	SS	10-4	13-7	17-4	21-1	10-4	13-7	17-4	21-0
	Douglas Fir-Larch	#1	9-11	13-1	16-5	19-1	9-8	12-4	15-0	17-5
	Douglas Fir-Larch	#2	9-9	12-7	15-5	17-10	9-1	11-6	14-1	16-3
	Douglas Fir-Larch	#3	7-6	9-6	11-8	13-6	6-10	8-8	10-7	12-4
	Hem-Fir	SS	9-9	12-10	16-5	19-11	9-9	12-10	16-5	19-11
	Hem-Fir	#1	9-6	12-7	16-0	18-7	9-6	12-0	14-8	17-0
	Hem-Fir	#2	9-1	12-0	15-2	17-7	8-11	11-4	13-10	16-1
	Hem-Fir	#3	7-6	9-6	11-8	13-6	6-10	8-8	10-7	12-4
	Southern Pine	SS	10-2	13-4	17-0	20-9	10-2	13-4	17-0	20-9
	Southern Pine	#1	9-11	13-1	16-9	20-4	9-11	13-1	16-4	19-6
	Southern Pine	#2	9-9	12-10	16-1	18-10	9-6	12-4	14-8	17-2
	Southern Pine	#3	8-1	10-3	12-2	14-6	7-4	9-5	11-1	13-2
	Spruce-Pine-Fir	SS	9-6	12-7	16-0	19-6	9-6	12-7	16-0	19-6
	Spruce-Pine-Fir	#1	9-4	12-3	15-5	17-10	9-1	11-6	14-1	16-3
	Spruce-Pine-Fir	#2	9-4	12-3	15-5	17-10	9-1	11-6	14-1	16-3
	Spruce-Pine-Fir	#3	7-6	9-6	11-8	13-6	6-10	8-8	10-7	12-4

(continued)

TABLE 2308.8(2)—continued
FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES
(Residential Living Areas, Live Load = 40 psf, L/Δ = 360)

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2x6	2x8	2x10	2x12	2x6	2x8	2x10	2x12
			Maximum floor joist spans							
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas Fir-Larch	SS	9-8	12-10	16-4	19-10	9-8	12-10	16-4	19-2
	Douglas Fir-Larch	#1	9-4	12-4	15-0	17-5	8-10	11-3	13-8	15-11
	Douglas Fir-Larch	#2	9-1	11-6	14-1	16-3	8-3	10-6	12-10	14-10
	Douglas Fir-Larch	#3	6-10	8-8	10-7	12-4	6-3	7-11	9-8	11-3
	Hem-Fir	SS	9-2	12-1	15-5	18-9	9-2	12-1	15-5	18-9
	Hem-Fir	#1	9-0	11-10	14-8	17-0	8-8	10-11	13-4	15-6
	Hem-Fir	#2	8-7	11-3	13-10	16-1	8-2	10-4	12-8	14-8
	Hem-Fir	#3	6-10	8-8	10-7	12-4	6-3	7-11	9-8	11-3
	Southern Pine	SS	9-6	12-7	16-0	19-6	9-6	12-7	16-0	19-6
	Southern Pine	#1	9-4	12-4	15-9	19-2	9-4	12-4	14-11	17-9
	Southern Pine	#2	9-2	12 -1	14-8	17-2	8-8	11-3	13-5	15-8
	Southern Pine	#3	7-4	9-5	11-1	13-2	6-9	8-7	10-1	12-1
	Spruce-Pine-Fir	SS	9-0	11-10	15-1	18-4	9-0	11-10	15-1	17-9
	Spruce-Pine-Fir	#1	8-9	11-6	14-1	16-3	8-3	10-6	12-10	14-10
	Spruce-Pine-Fir	#2	8-9	11-6	14-1	16-3	8-3	10-6	12-10	14-10
	Spruce-Pine-Fir	#3	6-10	8-8	10-7	12-4	6-3	7-11	9-8	11-3
24	Douglas Fir-Larch	SS	9-0	11-11	15-2	18-5	9-0	11-11	14-9	17-1
	Douglas Fir-Larch	#1	8-8	11-0	13-5	15-7	7-11	10-0	12-3	14-3
	Douglas Fir-Larch	#2	8-1	10-3	12-7	14-7	7-5	9-5	11-6	13-4
	Douglas Fir-Larch	#3	6-2	7-9	9-6	11-0	5-7	7-1	8-8	10-1
	Hem-Fir	SS	8-6	11-3	14-4	17-5	8-6	11-3	14-4	16-10[a]
	Hem-Fir	#1	8-4	10-9	13-1	15-2	7-9	9-9	11-11	13-10
	Hem-Fir	#2	7-11	10-2	12-5	14-4	7-4	9-3	11-4	13-1
	Hem-Fir	#3	6-2	7-9	9-6	11-0	5-7	7-1	8-8	10-1
	Southern Pine	SS	8-10	11-8	14-11	18-1	8-10	11-8	14-11	18-1
	Southern Pine	#1	8-8	11-5	14-7	17-5	8-8	11-3	13-4	15-11
	Southern Pine	#2	8-6	11-0	13-1	15-5	7-9	10-0	12-0	14-0
	Southern Pine	#3	6-7	8-5	9-11	11-10	6-0	7-8	9-1	10-9
	Spruce-Pine-Fir	SS	8-4	11-0	14-0	17-0	8-4	11-0	13-8	15-11
	Spruce-Pine-Fir	#1	8-1	10-3	12-7	14-7	7-5	9-5	11-6	13-4
	Spruce-Pine-Fir	#2	8-1	10-3	12-7	14-7	7-5	9-5	11-6	13-4
	Spruce-Pine-Fir	#3	6-2	7-9	9-6	11-0	5-7	7-1	8-8	10-1

Check sources for availability of lumber in lengths greater than 20 feet.
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.8 N/m^2.
a. End bearing length shall be increased to 2 inches.

TABLE 2308.9.1
SIZE, HEIGHT AND SPACING OF WOOD STUDS

STUD SIZE (inches)	BEARING WALLS				NONBEARING WALLS	
	Laterally unsupported stud height[a] (feet)	Supporting roof and ceiling only	Supporting one floor, roof and ceiling	Supporting two floors, roof and ceiling	Laterally unsupported stud height[a] (feet)	Spacing (inches)
		Spacing (inches)				
2 × 3[b]	—	—	—	—	10	16
2 × 4	10	24	16	—	14	24
3 × 4	10	24	24	16	14	24
2 × 5	10	24	24	—	16	24
2 × 6	10	24	24	16	20	24

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. Listed heights are distances between points of lateral support placed perpendicular to the plane of the wall. Increases in unsupported height are permitted where justified by an analysis.

b. Shall not be used in exterior walls.

2308.9.2 Framing details. Studs shall be placed with their wide dimension perpendicular to the wall. Not less than three studs shall be installed at each corner of an exterior wall.

Exception: At corners, two studs are permitted, provided wood spacers or backup cleats of $^3/_8$-inch-thick (9.5 mm) wood structural panel, $^3/_8$-inch (9.5 mm) Type M "Exterior Glue" particleboard, 1-inch-thick (25 mm) lumber or other approved devices that will serve as an adequate backing for the attachment of facing materials are used. Where fire-resistance ratings or shear values are involved, wood spacers, backup cleats or other devices shall not be used unless specifically approved for such use.

2308.9.2.1 Top plates. Bearing and exterior wall studs shall be capped with double top plates installed to provide overlapping at corners and at intersections with other partitions. End joints in double top plates shall be offset at least 48 inches (1219 mm), and shall be nailed with not less than eight 16d face nails on each side of the joint. Plates shall be a nominal 2 inches (51 mm) in depth and have a width at least equal to the width of the studs.

Exception: A single top plate is permitted, provided the plate is adequately tied at joints, corners and intersecting walls by at least the equivalent of 3-inch by 6-inch (76 mm by 152 mm) by 0.036-inch-thick (0.914 mm) galvanized steel that is nailed to each wall or segment of wall by six 8d nails or equivalent, provided the rafters, joists or trusses are centered over the studs with a tolerance of no more than 1 inch (25 mm).

2308.9.2.2 Top plates for studs spaced at 24 inches (610 mm). Where bearing studs are spaced at 24-inch (610 mm) intervals and top plates are less than two 2-inch by 6-inch (51 mm by 152 mm) or two 3-inch by 4-inch (76 mm by 102 mm) members and where the floor joists, floor trusses or roof trusses that they support are spaced at more than 16-inch (406 mm) intervals, such joists or trusses shall bear within 5 inches (127 mm) of the studs beneath or a third plate shall be installed.

2308.9.2.3 Nonbearing walls and partitions. In nonbearing walls and partitions, studs shall be spaced not more than 28 inches (711 mm) o.c. and are permitted to be set with the long dimension parallel to the wall. Interior nonbearing partitions shall be capped with no less than a single top plate installed to provide overlapping at corners and at intersections with other walls and partitions. The plate shall be continuously tied at joints by solid blocking at least 16 inches (406 mm) in length and equal in size to the plate or by $^1/_2$-inch by $1^1/_2$-inch (12.7 mm by 38 mm) metal ties with spliced sections fastened with two 16d nails on each side of the joint.

2308.9.2.4 Plates or sills. Studs shall have full bearing on a plate or sill not less than 2 inches (51 mm) in thickness having a width not less than that of the wall studs.

2308.9.3 Bracing. Braced wall lines shall consist of braced wall panels that meet the requirements for location, type and amount of bracing as shown in Figure 2308.9.3, specified in Table 2308.9.3(1) and are in line or offset from each other by not more than 4 feet (1219 mm). Braced wall panels shall start not more than $12^1/_2$-feet (3810 mm) from each end of a braced wall line. Braced wall panels shall be clearly indicated on the plans. Construction of braced wall panels shall be by one of the following methods:

1. Nominal 1-inch by 4-inch (25 mm by 102 mm) continuous diagonal braces let into top and bottom plates and intervening studs, placed at an angle not more than 60 degrees (1.0 rad) or less than 45 degrees (0.79 rad) from the horizontal and attached to the framing in conformance with Table 2304.9.1.
2. Wood boards of $^5/_8$ inch (15.9 mm) net minimum thickness applied diagonally on studs spaced not over 24 inches (610 mm) o.c.
3. Wood structural panel sheathing with a thickness not less than $^5/_{16}$ inch (7.9 mm) for a 16-inch (406 mm) stud spacing and not less than $^3/_8$ inch (9.5 mm) for a 24-inch (610 mm) stud spacing in accordance with Tables 2308.9.3(2) and 2308.9.3(3).
4. Fiberboard sheathing panels not less than $^1/_2$ inch (12.7 mm) thick applied vertically or horizontally on studs spaced not over 16 inches (406 mm) o.c. where

installed with fasteners in accordance with Section 2306.4.4 and Table 2306.4.4.

5. Gypsum board [sheathing $^1/_2$-inch-thick (12.7 mm) by 4-feet-wide (1219 mm) wallboard or veneer base] on studs spaced not over 24 inches (610 mm) o.c. and nailed at 7 inches (178 mm) o.c. with nails as required by Table 2306.4.5.
6. Particleboard wall sheathing panels where installed in accordance with Table 2308.9.3(4).
7. Portland cement plaster on studs spaced 16 inches (406 mm) o.c. installed in accordance with Section 2510.
8. Hardboard panel siding where installed in accordance with Section 2303.1.6 and Table 2308.9.3(5).

For cripple wall bracing, see Section 2308.9.4.1. For Methods 2, 3, 4, 6, 7 and 8, each panel must be at least 48 inches (1219 mm) in length, covering three stud spaces where studs are spaced 16 inches (406 mm) apart and covering two stud spaces where studs are spaced 24 inches (610 mm) apart.

For Method 5, each panel must be at least 96 inches (2438 mm) in length where applied to one face of a panel and 48 inches (1219 mm) where applied to both faces.

All vertical joints of panel sheathing shall occur over studs and adjacent panel joints shall be nailed to common framing members. Horizontal joints shall occur over blocking or other framing equal in size to the studding except where waived by the installation requirements for the specific sheathing materials.

Sole plates shall be nailed to the floor framing and top plates shall be connected to the framing above in accordance with Section 2308.3.2. Where joists are perpendicular to braced wall lines above, blocking shall be provided under and in line with the braced wall panels.

2308.9.3.1 Alternative bracing. Any bracing required by Section 2308.9.3 is permitted to be replaced by the following:

1. In one-story buildings, each panel shall have a length of not less than 2 feet 8 inches (813 mm) and a height of not more than 10 feet (3048 mm). Each panel shall be sheathed on one face with $^3/_8$-inch-minimum-thickness (9.5 mm) wood structural panel sheathing nailed with 8d common or galvanized box nails in accordance with Table 2304.9.1 and blocked at wood structural panel edges. Two anchor bolts installed in accordance with Section 2308.6 shall be provided in each panel. Anchor bolts shall be placed at each panel outside quarter points. Each panel end stud shall have a tie-down device fastened to the foundation, capable of providing an approved uplift capacity of not less than 1,800 pounds (8006 N). The tie-down device shall be installed in accordance with the manufacturer's recommendations. The panels shall be supported directly on a foundation or on floor framing supported directly on a foundation that is continuous across the entire length of the braced wall line. This foundation shall be reinforced with not less than one No. 4 bar top and bottom.

   Where the continuous foundation is required to have a depth greater than 12 inches (305 mm), a minimum 12-inch by 12-inch (305 mm by 305 mm) continuous footing or turned down slab edge is permitted at door openings in the braced wall line. This continuous footing or turned down slab edge shall be reinforced with not less than one No. 4 bar top and bottom. This reinforcement shall be lapped 15 inches (381 mm) with the reinforcement required in the continuous foundation located directly under the braced wall line.
2. In the first story of two-story buildings, each wall panel shall be braced in accordance with Section 2308.9.3.1, Item 1, except that the wood structural panel sheathing shall be provided on both faces, three anchor bolts shall be placed at one-quarter points, and tie-down device uplift capacity shall not be less than 3,000 pounds (13 344 N).

2308.9.3.2 Alternate bracing wall panel adjacent to a door or window opening. Any bracing required by Section 2308.9.3 is permitted to be replaced by the following when used adjacent to a door or window opening with a full-length header:

1. In one-story buildings, each panel shall have a length of not less than 16 inches (406 mm) and a height of not more than 10 feet (3048 mm). Each panel shall be sheathed on one face with a single layer of $^3/_8$ inch (9.5 mm) minimum thickness wood structural panel sheathing nailed with 8d common or galvanized box nails in accordance with Figure 2308.9.3.2. The wood structural panel sheathing shall extend up over the solid sawn or glued-laminated header and shall be nailed in accordance with Figure 2308.9.3.2. A built-up header consisting of at least two 2 x 12s and fastened in accordance with Item 24 of Table 2304.9.1 shall be permitted to be used. A spacer, if used, shall be placed on the side of the built-up beam opposite the wood structural panel sheathing. The header shall extend between the inside faces of the first full-length outer studs of each panel. The clear span of the header between the inner studs of each panel shall be not less than 6 feet (1829 mm) and not more than 18 feet (5486 mm) in length. A strap with an uplift capacity of not less than 1,000 pounds (4,400 N) shall fasten the header to the inner studs opposite the sheathing. One anchor bolt not less than $^5/_8$ inch (15.9 mm) diameter and installed in accordance with Section 2308.6 shall be provided in the center of each sill plate. The studs at each end of the panel shall have a tie-down device fastened to the foundation with an uplift capacity of not less than 4,200 pounds (18 480 N).

   Where a panel is located on one side of the opening, the header shall extend between the inside face of the first full-length stud of the panel and the bearing studs at the other end of the opening. A strap with an uplift capacity of not less than 1,000 pounds (4400 N) shall fasten the header to the bearing studs. The bearing studs shall also have a tie-down device fastened to the foundation with an uplift capacity of not less than 1,000 pounds (4400 N).

The tie-down devices shall be an embedded strap type, installed in accordance with the manufacturer's recommendations. The panels shall be supported directly on a foundation that is continuous across the entire length of the braced wall line. This foundation shall be reinforced with not less than one No. 4 bar top and bottom.

Where the continuous foundation is required to have a depth greater than 12 inches (305 mm), a minimum 12-inch by 12-inch (305 mm by 305 mm) continuous footing or turned down slab edge is permitted at door openings in the braced wall line. This continuous footing or turned down slab edge shall be reinforced with not less than one No. 4 bar top and bottom. This reinforcement shall be lapped not less than 15 inches (381 mm) with the reinforcement required in the continuous foundation located directly under the braced wall line.

2. In the first story of two-story buildings, each wall panel shall be braced in accordance with Item 1 above, except that each panel shall have a length of not less than 24 inches (610 mm).

2308.9.4 Cripple walls. Foundation cripple walls shall be framed of studs not less in size than the studding above with a minimum length of 14 inches (356 mm), or shall be framed of solid blocking. Where exceeding 4 feet (1219 mm) in height, such walls shall be framed of studs having the size required for an additional story.

2308.9.4.1 Bracing. For the purposes of this section, cripple walls having a stud height exceeding 14 inches (356 mm) shall be considered a story and shall be braced in accordance with Table 2308.9.3(1).

2308.9.4.2 Nailing of bracing. Spacing of edge nailing for required wall bracing shall not exceed 6 inches (152 mm) o.c. along the foundation plate and the top plate of the cripple wall. Nail size, nail spacing for field nailing and more restrictive boundary nailing requirements shall be as required elsewhere in the code for the specific bracing material used.

2308.9.5 Openings in exterior walls.

2308.9.5.1 Headers. Headers shall be provided over each opening in exterior-bearing walls. The spans in Table 2308.9.5 are permitted to be used for one- and two-family dwellings. Headers for other buildings shall be designed in accordance with Section 2301.2, Item 1 or 2. Headers shall be of two pieces of nominal 2-inch (51 mm) framing lumber set on edge as permitted by Table 2308.9.5 and nailed together in accordance with Table 2304.9.1 or of solid lumber of equivalent size.

2308.9.5.2 Header support. Wall studs shall support the ends of the header in accordance with Table 2308.9.5. Each end of a lintel or header shall have a length of bearing of not less than $1^1/_2$ inches (38 mm) for the full width of the lintel.

2308.9.6 Openings in interior bearing partitions. Headers shall be provided over each opening in interior bearing partitions as required in Section 2308.9.5. The spans in Table 2308.9.6 are permitted to be used. Wall studs shall support the ends of the header in accordance with Table 2308.9.5 or 2308.9.6, as appropriate.

2308.9.7 Openings in interior nonbearing partitions. Openings in nonbearing partitions are permitted to be framed with single studs and headers. Each end of a lintel or header shall have a length of bearing of not less than $1^1/_2$ inches (38 mm) for the full width of the lintel.

2308.9.8 Pipes in walls. Stud partitions containing plumbing, heating or other pipes shall be so framed and the joists underneath so spaced as to give proper clearance for the piping. Where a partition containing such piping runs parallel to the floor joists, the joists underneath such partitions shall be doubled and spaced to permit the passage of such pipes and shall be bridged. Where plumbing, heating or other pipes are placed in or partly in a partition, necessitating the cutting of the soles or plates, a metal tie not less than 0.058 inch (1.47 mm) (16 galvanized gage) and $1^1/_2$ inches (38 mm) wide shall be fastened to each plate across and to each side of the opening with not less than six 16d nails.

2308.9.9 Bridging. Unless covered by interior or exterior wall coverings or sheathing meeting the minimum requirements of this code, stud partitions or walls with studs having a height-to-least-thickness ratio exceeding 50 shall have bridging not less than 2 inches (51 mm) in thickness and of the same width as the studs fitted snugly and nailed thereto to provide adequate lateral support. Bridging shall be placed in every stud cavity and at a frequency such that no stud so braced shall have a height-to-least-thickness ratio exceeding 50 with the height of the stud measured between horizontal framing and bridging or between bridging, whichever is greater.

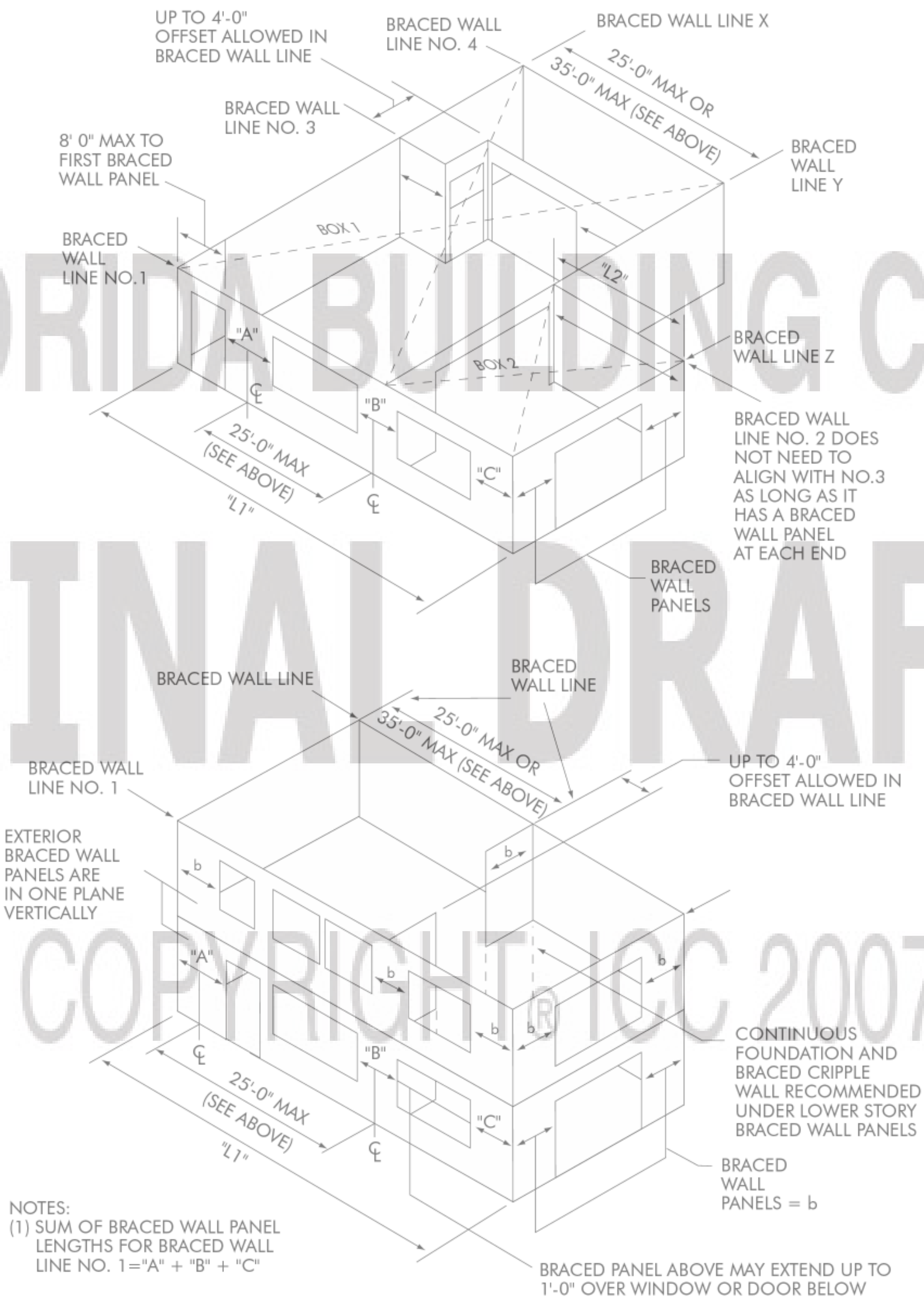
2308.9.10 Cutting and notching. In exterior walls and bearing partitions, any wood stud is permitted to be cut or notched to a depth not exceeding 25 percent of its width. Cutting or notching of studs to a depth not greater than 40 percent of the width of the stud is permitted in nonbearing partitions supporting no loads other than the weight of the partition.

2308.9.11 Bored holes. A hole not greater in diameter than 40 percent of the stud width is permitted to be bored in any wood stud. Bored holes not greater than 60 percent of the width of the stud are permitted in nonbearing partitions or in any wall where each bored stud is doubled, provided not more than two such successive doubled studs are so bored.

In no case shall the edge of the bored hole be nearer than $^5/_8$ inch (15.9 mm) to the edge of the stud.

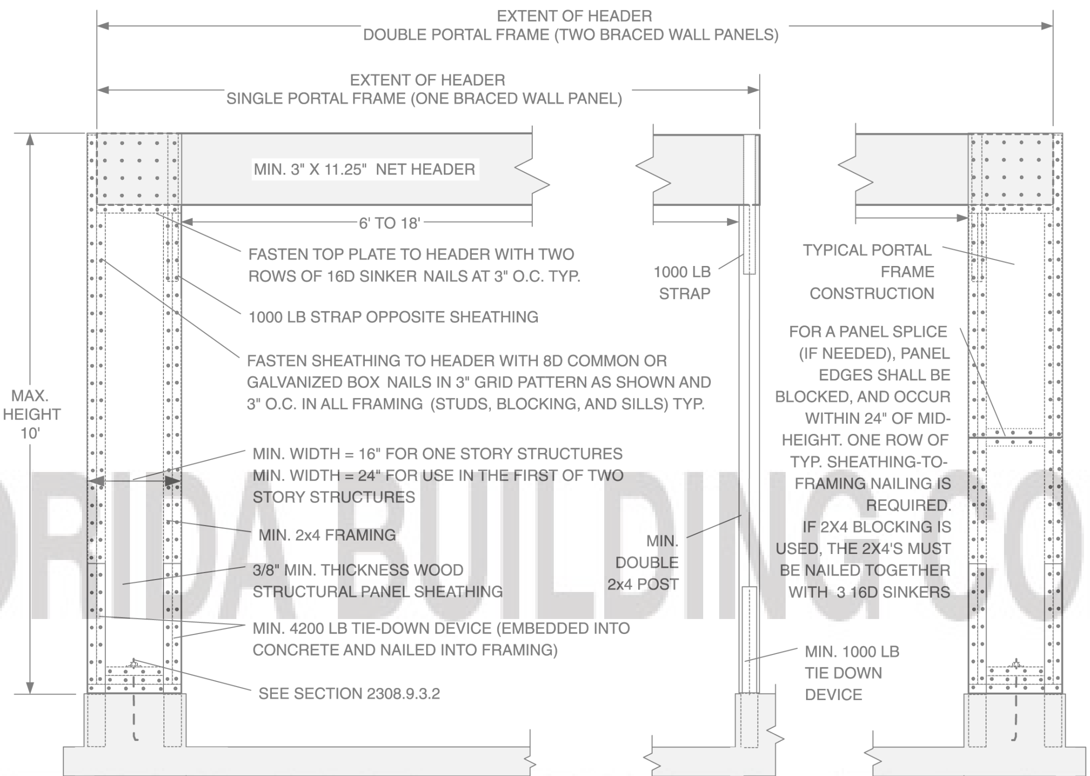
Bored holes shall not be located at the same section of stud as a cut or notch.

MAXIMUM WALL SPACING (feet)	REQUIRED BRACING LENGTH, b
35'-0"	Table 2308.9.3(1) and Section 2308.9.3



For SI: 1 foot = 304.8 mm.

FIGURE 2308.9.3
BASIC COMPONENTS OF THE LATERAL BRACING SYSTEM



For SI: 1 foot = 304.8 mm; 1 inch = 25.4 mm; 1 pound = 4.448 N.

FIGURE 2308.9.3.2
ALTERNATE BRACED WALL PANEL ADJACENT TO A DOOR OR WINDOW OPENING

TABLE 2308.9.3(1)
BRACED WALL PANELS[a]

CONDITION	CONSTRUCTION METHODS[b,c] 1	2	3	4	5	6	7	8	BRACED PANEL LOCATION AND LENGTH[d]
One story, top of two or three story	X	X	X	X	X	X	X	X	Location in accordance with Section 2308.9.3 and not more than 25 feet on center
First story of two story or second story of three story	X	X	X	X	X	X	X	X	
First story of three story	—	X	X	X	X	X	X	X	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.
a. This table specifies minimum requirements for braced panels that form interior or exterior braced wall lines.
b. See Section 2308.9.3 for full description.
c. See Sections 2308.9.3.1 for alternative braced panel requirements.
d. Building length is the dimension parallel to the braced wall length.
e. Reserved.
f. Reserved.

TABLE 2308.9.3(2)
EXPOSED PLYWOOD PANEL SIDING

MINIMUM THICKNESS[a] (inch)	MINIMUM NUMBER OF PLIES	STUD SPACING (inches) Plywood siding applied directly to studs or over sheathing
$^{3}/_{8}$	3	16[b]
$^{1}/_{2}$	4	24

For SI: 1 inch = 25.4 mm.
a. Thickness of grooved panels is measured at bottom of grooves.
b. Spans are permitted to be 24 inches if plywood siding applied with face grain perpendicular to studs or over one of the following: (1) 1-inch board sheathing, (2) $^{7}/_{16}$-inch wood structural panel sheathing or (3) $^{3}/_{8}$–inch wood structural panel sheathing with strength axis (which is the long direction of the panel unless otherwise marked) of sheathing perpendicular to studs.

TABLE 2308.9.3(3)
WOOD STRUCTURAL PANEL WALL SHEATHING[b]
(Not Exposed to the Weather, Strength Axis Parallel or Perpendicular to Studs Except as Indicated Below)

MINIMUM THICKNESS (inch)	PANEL SPAN RATING	STUD SPACING (inches)		
			Nailable sheathing	
		Siding nailed to studs	Sheathing parallel to studs	Sheathing perpendicular to studs
$^{5}/_{16}$	12/0, 16/0, 20/0 Wall–16″ o.c.	16	—	16
$^{3}/_{8}$, $^{15}/_{32}$, $^{1}/_{2}$	16/0, 20/0, 24/0, 32/16 Wall–24″ o.c.	24	16	24
$^{7}/_{16}$, $^{15}/_{32}$, $^{1}/_{2}$	24/0, 24/16, 32/16 Wall–24″ o.c.	24	24[a]	24

For SI: 1 inch = 25.4 mm.
a. Plywood shall consist of four or more plies.
b. Blocking of horizontal joints shall not be required except as specified in Sections 2306.4 and 2308.12.4.

TABLE 2308.9.3(4)
ALLOWABLE SPANS FOR PARTICLEBOARD WALL SHEATHING
(Not Exposed to the Weather, Long Dimension of the Panel Parallel or Perpendicular to Studs)

GRADE	THICKNESS (inch)	STUD SPACING (inches)	
		Siding nailed to studs	Sheathing under coverings specified in Section 2308.9.3 parallel or perpendicular to studs
M-S "Exterior Glue" and M-2"Exterior Glue"	$^{3}/_{8}$	16	—
	$^{1}/_{2}$	16	16

For SI: 1 inch = 25.4 mm.

TABLE 2308.9.3(5)
HARDBOARD SIDING

SIDING	MINIMUM NOMINAL THICKNESS (inch)	2 × 4 FRAMING MAXIMUM SPACING	NAIL SIZE[a,b,d]	NAIL SPACING	
				General	Bracing panels[c]
1. Lap siding					
Direct to studs	$^{3}/_{8}$	16″ o.c.	8d	16″ o.c.	Not applicable
Over sheathing	$^{3}/_{8}$	16″ o.c.	10d	16″ o.c.	Not applicable
2. Square edge panel siding					
Direct to studs	$^{3}/_{8}$	24″ o.c.	6d	6″ o.c. edges; 12″ o.c. at intermediate supports	4″ o.c. edges; 8″ o.c. at intermediate supports
Over sheathing	$^{3}/_{8}$	24″ o.c.	8d	6″ o.c. edges; 12″ o.c. at intermediate supports	4″ o.c. edges; 8″ o.c. at intermediate supports
3. Shiplap edge panel siding					
Direct to studs	$^{3}/_{8}$	16″ o.c.	6d	6″ o.c. edges; 12″ o.c. at intermediate supports	4″ o.c. edges; 8″ o.c. at intermediate supports
Over sheathing	$^{3}/_{8}$	16″ o.c.	8d	6″ o.c. edges; 12″ o.c. At intermediate supports	4″ o.c. edges; 8″ o.c. at intermediate supports

For SI: 1 inch = 25.4 mm.

a. Nails shall be corrosion resistant.

b. Minimum acceptable nail dimensions:

	Panel Siding (inch)	Lap Siding (inch)
Shank diameter	0.092	0.099
Head diameter	0.225	0.240

c. Where used to comply with Section 2308.9.3.

d. Nail length must accommodate the sheathing and penetrate framing $1^{1}/_{2}$ inches.

2308.10 Roof and ceiling framing. The framing details required in this section apply to roofs having a minimum slope of three units vertical in 12 units horizontal (25-percent slope) or greater. Where the roof slope is less than three units vertical in 12 units horizontal (25-percent slope), members supporting rafters and ceiling joists such as ridge board, hips and valleys shall be designed as beams.

2308.10.1 Wind uplift. Roof assemblies shall have rafter and truss ties to the wall below. Resultant uplift loads shall be transferred to the foundation using a continuous load path. The rafter or truss to wall connection shall comply with Tables 2304.9.1 and 2308.10.1.

2308.10.2 Ceiling joist spans. Allowable spans for ceiling joists shall be in accordance with Table 2308.10.2(1) or 2308.10.2(2). For other grades and species, refer to the *AF&PA Span Tables for Joists and Rafters*.

2308.10.3 Rafter spans. Allowable spans for rafters shall be in accordance with Table 2308.10.3(1), 2308.10.3(2), 2308.10.3(3), 2308.10.3(4), 2308.10.3(5) or 2308.10.3(6). For other grades and species, refer to the *AF&PA Span Tables for Joists and Rafters*.

Table 2308.10.3(3) Rafter Spans for Common Lumber Species (Ground Snow Load = 30 pounds per square foot, Ceiling Not Attached to Rafters, L/Δ = 180). Reserved.

Table 2308.10.3(4) Rafter Spans for Common Lumber Species. (Ground Snow Load = 50 pounds per square foot. Ceiling Not Attached to Rafters, L/Δ = 180). Reserved.

Table 2308.10.3(5) Rafter Spans for Common Lumber Species (Ground Snow Load = 30 pounds per square foot, Ceiling Attached to Rafters, L/Δ = 240). Reserved.

Table 2308.10.3(6) Rafter Spans for Common Lumber Species. (Ground Snow Load = 50 pounds per square foot. Ceiling Attached to Rafters, L/Δ = 240). Reserved.

2308.10.4 Ceiling joist and rafter framing. Rafters shall be framed directly opposite each other at the ridge. There shall be a ridge board at least 1-inch (25 mm) nominal thickness at ridges and not less in depth than the cut end of the rafter. At valleys and hips, there shall be a single valley or hip rafter not less than 2-inch (51 mm) nominal thickness and not less in depth than the cut end of the rafter.

2308.10.4.1 Ceiling joist and rafter connections. Ceiling joists and rafters shall be nailed to each other and the assembly shall be nailed to the top wall plate in accordance with Tables 2304.9.1 and 2308.10.1. Ceiling joists shall be continuous or securely joined where they meet over interior partitions and fastened to adjacent rafters in accordance with Tables 2308.10.4.1 and 2304.9.1 to provide a continuous rafter tie across the building where such joists are parallel to the rafters. Ceiling joists shall

TABLE 2308.9.5
HEADER AND GIRDER SPANS[a] FOR EXTERIOR BEARING WALLS
(Maximum Spans for Douglas Fir-Larch, Hem-Fir, Southern Pine and Spruce-Pine-Fir[b] and Required Number of Jack Studs)

HEADERS SUPPORTING	SIZE	Building width[c] (feet)					
		20		28		36	
		Span	NJ[d]	Span	NJ[d]	Span	NJ[d]
Roof & Ceiling	2-2 × 4	3-6	1	3-2	1	2-10	1
	2-2 × 6	5-5	1	4-8	1	4-2	1
	2-2 × 8	6-10	1	5-11	2	5-4	2
	2-2 × 10	8-5	2	7-3	2	6-6	2
	2-2 × 12	9-9	2	8-5	2	7-6	2
	3-2 × 8	8-4	1	7-5	1	6-8	1
	3-2 × 10	10-6	1	9-1	2	8-2	2
	3-2 × 12	12-2	2	10-7	2	9-5	2
	4-2 × 8	9-2	1	8-4	1	7-8	1
	4-2 × 10	11-8	1	10-6	1	9-5	2
	4-2 × 12	14-1	1	12-2	2	10-11	2
Roof Ceiling & 1 Center-Bearing Floor	2-2 × 4	3-1	1	2-9	1	2-5	1
	2-2 × 6	4-6	1	4-0	1	3-7	2
	2-2 × 8	5-9	2	5-0	2	4-6	2
	2-2 × 10	7-0	2	6-2	2	5-6	2
	2-2 × 12	8-1	2	7-1	2	6-5	2
	3-2 × 8	7-2	1	6-3	2	5-8	2
	3-2 × 10	8-9	2	7-8	2	6-11	2
	3-2 × 12	10-2	2	8-11	2	8-0	2
	4-2 × 8	8-1	1	7-3	1	6-7	1
	4-2 × 10	10-1	1	8-10	2	8-0	2
	4-2 × 12	11-9	2	10-3	2	9-3	2
Roof Ceiling & 1 Clear Span Floor	2-2 × 4	2-8	1	2-4	1	2-1	1
	2-2 × 6	3-11	1	3-5	2	3-0	2
	2-2 × 8	5-0	2	4-4	2	3-10	2
	2-2 × 10	6-1	2	5-3	2	4-8	2
	2-2 × 12	7-1	2	6-1	3	5-5	3
	3-2 × 8	6-3	2	5-5	2	4-10	2
	3-2 × 10	7-7	2	6-7	2	5-11	2
	3-2 × 12	8-10	2	7-8	2	6-10	2
	4-2 × 8	7-2	1	6-3	2	5-7	2
	4-2 × 10	8-9	2	7-7	2	6-10	2
	4-2 × 12	10-2	2	8-10	2	7-11	2

(continued)

TABLE 2308.9.5—continued
HEADER AND GIRDER SPANS[a] FOR EXTERIOR BEARING WALLS
(Maximum Spans for Douglas Fir-Larch, Hem-Fir, Southern Pine and Spruce-Pine-Fir[b] and Required Number of Jack Studs)

HEADERS SUPPORTING	SIZE	Building width[c] (feet)					
		20		28		36	
		Span	NJ[d]	Span	NJ[d]	Span	NJ[d]
Roof, Ceiling & 2 Center-Bearing Floors	2-2 × 4	2-7	1	2-3	1	2-0	1
	2-2 × 6	3-9	2	3-3	2	2-11	2
	2-2 × 8	4-9	2	4-2	2	3-9	2
	2-2 × 10	5-9	2	5-1	2	4-7	3
	2-2 × 12	6-8	2	5-10	3	5-3	3
	3-2 × 8	5-11	2	5-2	2	4-8	2
	3-2 × 10	7-3	2	6-4	2	5-8	2
	3-2 × 12	8-5	2	7-4	2	6-7	2
	4-2 × 8	6-10	1	6-0	2	5-5	2
	4-2 × 10	8-4	2	7-4	2	6-7	2
	4-2 × 12	9-8	2	8-6	2	7-8	2
Roof, Ceiling & 2 Clear Span Floors	2-2 × 4	2-1	1	1-8	1	1-6	2
	2-2 × 6	3-1	2	2-8	2	2-4	2
	2-2 × 8	3-10	2	3-4	2	3-0	3
	2-2 × 10	4-9	2	4-1	3	3-8	3
	2-2 × 12	5-6	3	4-9	3	4-3	3
	3-2 × 8	4-10	2	4-2	2	3-9	2
	3-2 × 10	5-11	2	5-1	2	4-7	3
	3-2 × 12	6-10	2	5-11	3	5-4	3
	4-2 × 8	5-7	2	4-10	2	4-4	2
	4-2 × 10	6-10	2	5-11	2	5-3	2
	4-2 × 12	7-11	2	6-10	2	6-2	3

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.8 N/m^2.

a. Spans are given in feet and inches (ft-in).

b. Tabulated values are for No. 2 grade lumber.

c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.

d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.

e. Reserved.

TABLE 2308.9.6
HEADER AND GIRDER SPANS[a] FOR INTERIOR BEARING WALLS
(Maximum Spans for Douglas Fir-Larch, Hem-Fir, Southern Pine and Spruce-Pine-Fir[b] and Required Number of Jack Studs)

HEADERS AND GIRDERS SUPPORTING	SIZE	BUILDING WIDTH[c] (feet)					
		20		28		36	
		Span	NJ[d]	Span	NJ[d]	Span	NJ[d]
One Floor Only	2-2 × 4	3-1	1	2-8	1	2-5	1
	2-2 × 6	4-6	1	3-11	1	3-6	1
	2-2 × 8	5-9	1	5-0	2	4-5	2
	2-2 ×10	7-0	2	6-1	2	5-5	2
	2-2 ×12	8-1	2	7-0	2	6-3	2
	3-2 × 8	7-2	1	6-3	1	5-7	2
	3-2 ×10	8-9	1	7-7	2	6-9	2
	3-2 ×12	10-2	2	8-10	2	7-10	2
	4-2 × 8	9-0	1	7-8	1	6-9	1
	4-2 ×10	10-1	1	8-9	1	7-10	2
	4-2 ×12	11-9	1	10-2	2	9-1	2
Two Floors	2-2 × 4	2-2	1	1-10	1	1-7	1
	2-2 × 6	3-2	2	2-9	2	2-5	2
	2-2 × 8	4-1	2	3-6	2	3-2	2
	2-2 ×10	4-11	2	4-3	2	3-10	3
	2-2 ×12	5-9	2	5-0	3	4-5	3
	3-2 × 8	5-1	2	4-5	2	3-11	2
	3-2 ×10	6-2	2	5-4	2	4-10	2
	3-2 ×12	7-2	2	6-3	2	5-7	3
	4-2 × 8	6-1	1	5-3	2	4-8	2
	4-2 ×10	7-2	2	6-2	2	5-6	2
	4-2 ×12	8-4	2	7-2	2	6-5	2

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.
a. Spans are given in feet and inches (ft-in).
b. Tabulated values are for No. 2 grade lumber.
c. Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.
d. NJ - Number of jack studs required to support each end. Where the number of required jack studs equals one, the headers are permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.

TABLE 2308.10.1
REQUIRED RATING OF APPROVED UPLIFT CONNECTORS (pounds)[a,b,c,e,f,g,h]

BASIC WIND SPEED (3-second gust)	ROOF SPAN (feet)							OVERHANGS (pounds/feet)[d]
	12	20	24	28	32	36	40	
85	-72	-120	-145	-169	-193	-217	-241	-38.55
90	-91	-151	-181	-212	-242	-272	-302	-43.22
100	-131	-281	-262	-305	-349	-393	-436	-53.36
110	-175	-292	-351	-409	-467	-526	-584	-64.56

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 1.61 km/hr, 1 pound = 0.454 Kg, 1 pound/foot = 14.5939 N/m.

a. The uplift connection requirements are based on a 30-foot mean roof height located in Exposure B. For Exposure C or D and for other mean roof heights, multiply the above loads by the adjustment coefficients below.

EXPOSURE	Mean Roof Height (feet)									
	15	20	25	30	35	40	45	50	55	60
B	1.00	1.00	1.00	1.00	1.05	1.09	1.12	1.16	1.19	1.22
C	1.21	1.29	1.35	1.40	1.45	1.49	1.53	1.56	1.59	1.62
D	1.47	1.55	1.61	1.66	1.70	1.74	1.78	1.81	1.84	1.87

b. The uplift connection requirements are based on the framing being spaced 24 inches on center. Multiply by 0.67 for framing spaced 16 inches on center and multiply by 0.5 for framing spaced 12 inches on center.

c. The uplift connection requirements include an allowance for 10 pounds of dead load.

d. The uplift connection requirements do not account for the effects of overhangs. The magnitude of the above loads shall be increased by adding the overhang loads found in the table. The overhang loads are also based on framing spaced 24 inches on center. The overhang loads given shall be multiplied by the overhang projection and added to the roof uplift value in the table.

e. The uplift connection requirements are based upon wind loading on end zones as defined in Figure 6-2 of ASCE 7. Connection loads for connections located a distance of 20 percent of the least horizontal dimension of the building from the corner of the building are permitted to be reduced by multiplying the table connection value by 0.7 and multiplying the overhang load by 0.8.

f. For wall-to-wall and wall-to-foundation connections, the capacity of the uplift connector is permitted to be reduced by 100 pounds for each full wall above. (For example, if a 500-pound rated connector is used on the roof framing, a 400-pound rated connector is permitted at the next floor level down).

g. Interpolation is permitted for intermediate values of basic wind speeds and roof spans.

h. The rated capacity of approved tie-down devices is permitted to include up to a 60-percent increase for wind effects where allowed by material specifications.

have a bearing surface of not less than $1^1/_2$ inches (38 mm) on the top plate at each end.

Where ceiling joists are not parallel to rafters, an equivalent rafter tie shall be installed in a manner to provide a continuous tie across the building, at a spacing of not more than 4 feet (1219 mm) o.c. The connections shall be in accordance with Tables 2308.10.4.1 and 2304.9.1, or connections of equivalent capacities shall be provided. Where ceiling joists or rafter ties are not provided at the top of the rafter support walls, the ridge formed by these rafters shall also be supported by a girder conforming to Section 2308.4.

Rafter ties shall be spaced not more than 4 feet (1219 mm) o.c. Rafter tie connections shall be based on the equivalent rafter spacing in Table 2308.10.4.1. Where rafter ties are spaced at 32 inches (813 mm) o.c., the number of 16d common nails shall be two times the number specified for rafters spaced 16 inches (406 mm) o.c., with a minimum of 4-16d common nails where no snow loads are indicated. Where rafter ties are spaced at 48 inches (1219 mm) o.c., the number of 16d common nails shall be two times the number specified for rafters spaced 24 inches (610 mm) o.c., with a minimum of 6-16d common nails where no snow loads are indicated. Rafter/ceiling joist connections and rafter/tie connections shall be of sufficient size and number to prevent splitting from nailing.

2308.10.4.2 Notches and holes. Notching at the ends of rafters or ceiling joists shall not exceed one-fourth the depth. Notches in the top or bottom of the rafter or ceiling joist shall not exceed one-sixth the depth and shall not be located in the middle one-third of the span, except that a notch not exceeding one-third of the depth is permitted in the top of the rafter or ceiling joist not further from the face of the support than the depth of the member.

Holes bored in rafters or ceiling joists shall not be within 2 inches (51 mm) of the top and bottom and their diameter shall not exceed one-third the depth of the member.

2308.10.4.3 Framing around openings. Trimmer and header rafters shall be doubled, or of lumber of equivalent cross section, where the span of the header exceeds 4 feet (1219 mm). The ends of header rafters more than 6 feet (1829 mm) long shall be supported by framing anchors or rafter hangers unless bearing on a beam, partition or wall.

2308.10.5 Purlins. Purlins to support roof loads are permitted to be installed to reduce the span of rafters within allowable limits and shall be supported by struts to bearing walls. The maximum span of 2-inch by 4-inch (51 mm by 102 mm) purlins shall be 4 feet (1219 mm). The maximum span of the 2-inch by 6-inch (51 mm by 152 mm) purlin shall be 6 feet (1829 mm), but in no case shall the purlin be smaller than the supported rafter. Struts shall not be smaller than 2-inch by 4-inch (51 mm by 102 mm) members. The unbraced length of struts shall not exceed 8 feet (2438 mm) and the minimum slope of the struts shall not be less than 45 degrees (0.79 rad) from the horizontal.

TABLE 2308.10.2(1)
CEILING JOIST SPANS FOR COMMON LUMBER SPECIES
(Uninhabitable Attics Without Storage, Live Load = 10 pounds psf, L/Δ = 240)

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 5 pounds per square foot			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	13-2	20-8	Note a	Note a
	Douglas Fir-Larch	#1	12-8	19-11	Note a	Note a
	Douglas Fir-Larch	#2	12-5	19-6	25-8	Note a
	Douglas Fir-Larch	#3	10-10	15-10	20-1	24-6
	Hem-Fir	SS	12-5	19-6	25-8	Note a
	Hem-Fir	#1	12-2	19-1	25-2	Note a
	Hem-Fir	#2	11-7	18-2	24-0	Note a
	Hem-Fir	#3	10-10	15-10	20-1	24-6
	Southern Pine	SS	12-11	20-3	Note a	Note a
	Southern Pine	#1	12-8	19-11	Note a	Note a
	Southern Pine	#2	12-5	19-6	25-8	Note a
	Southern Pine	#3	11-6	17-0	21-8	25-7
	Spruce-Pine-Fir	SS	12-2	19-1	25-2	Note a
	Spruce-Pine-Fir	#1	11-10	18-8	24-7	Note a
	Spruce-Pine-Fir	#2	11-10	18-8	24-7	Note a
	Spruce-Pine-Fir	#3	10-10	15-10	20-1	24-6
16	Douglas Fir-Larch	SS	11-11	18-9	24-8	Note a
	Douglas Fir-Larch	#1	11-6	18-1	23-10	Note a
	Douglas Fir-Larch	#2	11-3	17-8	23-0	Note a
	Douglas Fir-Larch	#3	9-5	13-9	17-5	21-3
	Hem-Fir	SS	11-3	17-8	23-4	Note a
	Hem-Fir	#1	11-0	17-4	22-10	Note a
	Hem-Fir	#2	10-6	16-6	21-9	Note a
	Hem-Fir	#3	9-5	13-9	17-5	21-3
	Southern Pine	SS	11-9	18-5	24-3	Note a
	Southern Pine	#1	11-6	18-1	23-1	Note a
	Southern Pine	#2	11-3	17-8	23-4	Note a
	Southern Pine	#3	10-0	14-9	18-9	22-2
	Spruce-Pine-Fir	SS	11-0	17-4	22-10	Note a
	Spruce-Pine-Fir	#1	10-9	16-11	22-4	Note a
	Spruce-Pine-Fir	#2	10-9	16-11	22-4	Note a
	Spruce-Pine-Fir	#3	9-5	13-9	17-5	21-3

(continued)

TABLE 2308.10.2(1)—continued
CEILING JOIST SPANS FOR COMMON LUMBER SPECIES
(Uninhabitable Attics Without Storage, Live Load = 10 pounds psf, L/Δ = 240)

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 5 pounds per square foot			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas Fir-Larch	SS	11-3	17-8	23-3	Note a
	Douglas Fir-Larch	#1	10-10	17-0	22-5	Note a
	Douglas Fir-Larch	#2	10-7	16-7	21-0	25-8
	Douglas Fir-Larch	#3	8-7	12-6	15-10	19-5
	Hem-Fir	SS	10-7	16-8	21-11	Note a
	Hem-Fir	#1	10-4	16-4	21-6	Note a
	Hem-Fir	#2	9-11	15-7	20-6	25-3
	Hem-Fir	#3	8-7	12-6	15-10	19-5
	Southern Pine	SS	11-0	17-4	22-10	Note a
	Southern Pine	#1	10-10	17-0	22-5	Note a
	Southern Pine	#2	10-7	16-8	21-11	Note a
	Southern Pine	#3	9-1	13-6	17-2	20-3
	Spruce-Pine-Fir	SS	10-4	16-4	21-6	Note a
	Spruce-Pine-Fir	#1	10-2	15-11	21-0	25-8
	Spruce-Pine-Fir	#2	10-2	15-11	21-0	25-8
	Spruce-Pine-Fir	#3	8-7	12-6	15-10	19-5
24	Douglas Fir-Larch	SS	10-5	16-4	21-7	Note a
	Douglas Fir-Larch	#1	10-0	15-9	20-1	24-6
	Douglas Fir-Larch	#2	9-10	14-10	18-9	22-11
	Douglas Fir-Larch	#3	7-8	11-2	14-2	17-4
	Hem-Fir	SS	9-10	15-6	20-5	Note a
	Hem-Fir	#1	9-8	15-2	19-7	23-11
	Hem-Fir	#2	9-2	14-5	18-6	22-7
	Hem-Fir	#3	7-8	11-2	14-2	17-4
	Southern Pine	SS	10-3	16-1	21-2	Note a
	Southern Pine	#1	10-0	15-9	20-10	Note a
	Southern Pine	#2	9-10	15-6	20-1	23-11
	Southern Pine	#3	8-2	12-0	15-4	18-1
	Spruce-Pine-Fir	SS	9-8	15-2	19-11	25-5
	Spruce-Pine-Fir	#1	9-5	14-9	18-9	22-11
	Spruce-Pine-Fir	#2	9-5	14-9	18-9	22-11
	Spruce-Pine-Fir	#3	7-8	11-2	14-2	17-4

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.8 N/m^2.

a. Span exceeds 26 feet in length. Check sources for availability of lumber in lengths greater than 20 feet.

TABLE 2308.10.2(2)
CEILING JOIST SPANS FOR COMMON LUMBER SPECIES
(Uninhabitable Attics With Limited Storage, Live Load = 20 pounds per square foot, $L/\Delta = 240$)

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 pounds per square foot			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	10-5	16-4	21-7	Note a
	Douglas Fir-Larch	#1	10-0	15-9	20-1	24-6
	Douglas Fir-Larch	#2	9-10	14-10	18-9	22-11
	Douglas Fir-Larch	#3	7-8	11-2	14-2	17-4
	Hem-Fir	SS	9-10	15-6	20-5	Note a
	Hem-Fir	#1	9-8	15-2	19-7	23-11
	Hem-Fir	#2	9-2	14-5	18-6	22-7
	Hem-Fir	#3	7-8	11-2	14-2	17-4
	Southern Pine	SS	10-3	16-1	21-2	Note a
	Southern Pine	#1	10-0	15-9	20-10	Note a
	Southern Pine	#2	9-10	15-6	20-1	23-11
	Southern Pine	#3	8-2	12-0	15-4	18-1
	Spruce-Pine-Fir	SS	9-8	15-2	19-11	25-5
	Spruce-Pine-Fir	#1	9-5	14-9	18-9	22-11
	Spruce-Pine-Fir	#2	9-5	14-9	18-9	22-11
	Spruce-Pine-Fir	#3	7-8	11-2	14-2	17-4
16	Douglas Fir-Larch	SS	9-6	14-11	19-7	25-0
	Douglas Fir-Larch	#1	9-1	13-9	17-5	21-3
	Douglas Fir-Larch	#2	8-9	12-10	16-3	19-10
	Douglas Fir-Larch	#3	6-8	9-8	12-4	15-0
	Hem-Fir	SS	8-11	14-1	18-6	23-8
	Hem-Fir	#1	8-9	13-5	16-10	20-8
	Hem-Fir	#2	8-4	12-8	16-0	19-7
	Hem-Fir	#3	6-8	9-8	12-4	15-0
	Southern Pine	SS	9-4	14-7	19-3	24-7
	Southern Pine	#1	9-1	14-4	18-11	23-1
	Southern Pine	#2	8-11	13-6	17-5	20-9
	Southern Pine	#3	7-1	10-5	13-3	15-8
	Spruce-Pine-Fir	SS	8-9	13-9	18-1	23-1
	Spruce-Pine-Fir	#1	8-7	12-10	16-3	19-10
	Spruce-Pine-Fir	#2	8-7	12-10	16-3	19-10
	Spruce-Pine-Fir	#3	6-8	9-8	12-4	15-0

(continued)

TABLE 2308.10.2(2)—continued
CEILING JOIST SPANS FOR COMMON LUMBER SPECIES
(Uninhabitable Attics With Limited Storage, Live Load = 20 pounds per square foot, L/Δ = 240)

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 pounds per square foot			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas Fir-Larch	SS	8-11	14-0	18-5	23-4
	Douglas Fir-Larch	#1	8-7	12-6	15-10	19-5
	Douglas Fir-Larch	#2	8-0	11-9	14-10	18-2
	Douglas Fir-Larch	#3	6-1	8-10	11-3	13-8
	Hem-Fir	SS	8-5	13-3	17-5	22-3
	Hem-Fir	#1	8-3	12-3	15-6	18-11
	Hem-Fir	#2	7-10	11-7	14-8	17-10
	Hem-Fir	#3	6-1	8-10	11-3	13-8
	Southern Pine	SS	8-9	13-9	18-1	23-1
	Southern Pine	#1	8-7	13-6	17-9	21-1
	Southern Pine	#2	8-5	12-3	15-10	18-11
	Southern Pine	#3	6-5	9-6	12-1	14-4
	Spruce-Pine-Fir	SS	8-3	12-11	17-1	21-8
	Spruce-Pine-Fir	#1	8-0	11-9	14-10	18-2
	Spruce-Pine-Fir	#2	8-0	11-9	14-10	18-2
	Spruce-Pine-Fir	#3	6-1	8-10	11-3	13-8
24	Douglas Fir-Larch	SS	8-3	13-0	17-1	20-11
	Douglas Fir-Larch	#1	7-8	11-2	14-2	17-4
	Douglas Fir-Larch	#2	7-2	10-6	13-3	16-3
	Douglas Fir-Larch	#3	5-5	7-11	10-0	12-3
	Hem-Fir	SS	7-10	12-3	16-2	20-6
	Hem-Fir	#1	7-6	10-11	13-10	16-11
	Hem-Fir	#2	7-1	10-4	13-1	16-0
	Hem-Fir	#3	5-5	7-11	10-0	12-3
	Southern Pine	SS	8-1	12-9	16-10	21-6
	Southern Pine	#1	8-0	12-6	15-10	18-10
	Southern Pine	#2	7-8	11-0	14-2	16-11
	Southern Pine	#3	5-9	8-6	10-10	12-10
	Spruce-Pine-Fir	SS	7-8	12-0	15-10	19-5
	Spruce-Pine-Fir	#1	7-2	10-6	13-3	16-3
	Spruce-Pine-Fir	#2	7-2	10-6	13-3	16-3
	Spruce-Pine-Fir	#3	5-5	7-11	10-0	12-3

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.8 N/m^2.

a. Span exceeds 26 feet in length. Check sources for availability of lumber in lengths greater than 20 feet.

TABLE 2308.10.3(1)
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Roof Live Load = 20 pounds per square foot, Ceiling Not Attached to Rafters, $L/\Delta = 180$)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 pounds per square foot					DEAD LOAD = 20 pounds per square foot				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	11-6	18-0	23-9	Note a	Note a	11-6	18-0	23-5	Note a	Note a
	Douglas Fir-Larch	#1	11-1	17-4	22-5	Note a	Note a	10-6	15-4	19-5	23-9	Note a
	Douglas Fir-Larch	#2	10-10	16-7	21-0	25-8	Note a	9-10	14-4	18-2	22-3	25-9
	Douglas Fir-Larch	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Hem-Fir	SS	10-10	17-0	22-5	Note a	Note a	10-10	17-0	22-5	Note a	Note a
	Hem-Fir	#1	10-7	16-8	21-10	Note a	Note a	10-3	14-11	18-11	23-2	Note a
	Hem-Fir	#2	10-1	15-11	20-8	25-3	Note a	9-8	14-2	17-11	21-11	25-5
	Hem-Fir	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Southern Pine	SS	11-3	17-8	23-4	Note a	Note a	11-3	17-8	23-4	Note a	Note a
	Southern Pine	#1	11-1	17-4	22-11	Note a	Note a	11-1	17-3	21-9	25-10	Note a
	Southern Pine	#2	10-10	17-0	22-5	Note a	Note a	10-6	15-1	19-5	23-2	Note a
	Southern Pine	#3	9-1	13-6	17-2	20-3	24-1	7-11	11-8	14-10	17-6	20-11
	Spruce-Pine-Fir	SS	10-7	16-8	21-11	Note a	Note a	10-7	16-8	21-9	Note a	Note a
	Spruce-Pine-Fir	#1	10-4	16-3	21-0	25-8	Note a	9-10	14-4	18-2	22-3	25-9
	Spruce-Pine-Fir	#2	10-4	16-3	21-0	25-8	Note a	9-10	14-4	18-2	22-3	25-9
	Spruce-Pine-Fir	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
16	Douglas Fir-Larch	SS	10-5	16-4	21-7	Note a	Note a	10-5	16-0	20-3	24-9	Note a
	Douglas Fir-Larch	#1	10-0	15-4	19-5	23-9	Note a	9-1	13-3	16-10	20-7	23-10
	Douglas Fir-Larch	#2	9-10	14-4	18-2	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Douglas Fir-Larch	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10
	Hem-Fir	SS	9-10	15-6	20-5	Note a	Note a	9-10	15-6	19-11	24-4	Note a
	Hem-Fir	#1	9-8	14-11	18-11	23-2	Note a	8-10	12-11	16-5	20-0	23-3
	Hem-Fir	#2	9-2	14-2	17-11	21-11	25-5	8-5	12-3	15-6	18-11	22-0
	Hem-Fir	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10
	Southern Pine	SS	10-3	16-1	21-2	Note a	Note a	10-3	16-1	21-2	Note a	Note a
	Southern Pine	#1	10-0	15-9	20-10	25-10	Note a	10-0	15-0	18-10	22-4	Note a
	Southern Pine	#2	9-10	15-1	19-5	23-2	Note a	9-1	13-0	16-10	20-1	23-7
	Southern Pine	#3	7-11	11-8	14-10	17-6	20-11	6-10	10-1	12-10	15-2	18-1
	Spruce-Pine-Fir	SS	9-8	15-2	19-11	25-5	Note a	9-8	14-10	18-10	23-0	Note a
	Spruce-Pine-Fir	#1	9-5	14-4	18-2	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Spruce-Pine-Fir	#2	9-5	14-4	18-2	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Spruce-Pine-Fir	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10

(continued)

TABLE 2308.10.3(1)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Roof Live Load = 20 pounds per square foot, Ceiling Not Attached to Rafters, L/Δ = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 pounds per square foot					DEAD LOAD = 20 pounds per square foot				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas Fir-Larch	SS	9-10	15-5	20-4	25-11	Note a	9-10	14-7	18-6	22-7	Note a
	Douglas Fir-Larch	#1	9-5	14-0	17-9	21-8	25-2	8-4	12-2	15-4	18-9	21-9
	Douglas Fir-Larch	#2	8-11	13-1	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Douglas Fir-Larch	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5
	Hem-Fir	SS	9-3	14-7	19-2	24-6	Note a	9-3	14-4	18-2	22-3	25-9
	Hem-Fir	#1	9-1	13-8	17-4	21-1	24-6	8-1	11-10	15-0	18-4	21-3
	Hem-Fir	#2	8-8	12-11	16-4	20-0	23-2	7-8	11-2	14-2	17-4	20-1
	Hem-Fir	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5
	Southern Pine	SS	9-8	15-2	19-11	25-5	Note a	9-8	15-2	19-11	25-5	Note a
	Southern Pine	#1	9-5	14-10	19-7	23-7	Note a	9-3	13-8	17-2	20-5	24-4
	Southern Pine	#2	9-3	13-9	17-9	21-2	24-10	8-4	11-11	15-4	18-4	21-6
	Southern Pine	#3	7-3	10-8	13-7	16-0	19-1	6-3	9-3	11-9	13-10	16-6
	Spruce-Pine-Fir	SS	9-1	14-3	18-9	23-11	Note a	9-1	13-7	17-2	21-0	24-4
	Spruce-Pine-Fir	#1	8-10	13-1	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Spruce-Pine-Fir	#2	8-10	13-1	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Spruce-Pine-Fir	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5
24	Douglas Fir-Larch	SS	9-1	14-4	18-10	23-4	Note a	8-11	13-1	16-7	20-3	23-5
	Douglas Fir-Larch	#1	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Douglas Fir-Larch	#2	8-0	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Douglas Fir-Larch	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9
	Hem-Fir	SS	8-7	13-6	17-10	22-9	Note a	8-7	12-10	16-3	19-10	23-0
	Hem-Fir	#1	8-4	12-3	15-6	18-11	21-11	7-3	10-7	13-5	16-4	19-0
	Hem-Fir	#2	7-11	11-7	14-8	17-10	20-9	6-10	10-0	12-8	15-6	17-11
	Hem-Fir	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9
	Southern Pine	SS	8-11	14-1	18-6	23-8	Note a	8-11	14-1	18-6	22-11	Note a
	Southern Pine	#1	8-9	13-9	17-9	21-1	25-2	8-3	12-3	15-4	18-3	21-9
	Southern Pine	#2	8-7	12-3	15-10	18-11	22-2	7-5	10-8	13-9	16-5	19-3
	Southern Pine	#3	6-5	9-6	12-1	14-4	17-1	5-7	8-3	10-6	12-5	14-9
	Spruce-Pine-Fir	SS	8-5	13-3	17-5	21-8	25-2	8-4	12-2	15-4	18-9	21-9
	Spruce-Pine-Fir	#1	8-0	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Spruce-Pine-Fir	#2	8-0	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Spruce-Pine-Fir	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.9 N/m^2.

a. Span exceeds 26 feet in length. Check sources for availability of lumber in lengths greater than 20 feet.

TABLE 2308.10.3(2)
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Roof Live Load = 20 pounds per square foot, Ceiling Not Attached to Rafters, $L/\Delta = 240$)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 pounds per square foot					DEAD LOAD = 20 pounds per square foot				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	10-5	16-4	21-7	Note a	Note a	10-5	16-4	21-7	Note a	Note a
	Douglas Fir-Larch	#1	10-0	15-9	20-10	Note a	Note a	10-0	15-4	19-5	23-9	Note a
	Douglas Fir-Larch	#2	9-10	15-6	20-5	25-8	Note a	9-10	14-4	18-2	22-3	25-9
	Douglas Fir-Larch	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Hem-Fir	SS	9-10	15-6	20-5	Note a	Note a	9-10	15-6	20-5	Note a	Note a
	Hem-Fir	#1	9-8	15-2	19-11	25-5	Note a	9-8	14-11	18-11	23-2	Note a
	Hem-Fir	#2	9-2	14-5	19-0	24-3	Note a	9-2	14-2	17-11	21-11	25-5
	Hem-Fir	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Southern Pine	SS	10-3	16-1	21-2	Note a	Note a	10-3	16-1	21-2	Note a	Note a
	Southern Pine	#1	10-0	15-9	20-10	Note a	Note a	10-0	15-9	20-10	25-10	Note a
	Southern Pine	#2	9-10	15-6	20-5	Note a	Note a	9-10	15-1	19-5	23-2	Note a
	Southern Pine	#3	9-1	13-6	17-2	20-3	24-1	7-11	11-8	14-10	17-6	20-11
	Spruce-Pine-Fir	SS	9-8	15-2	19-11	25-5	Note a	9-8	15-2	19-11	25-5	Note a
	Spruce-Pine-Fir	#1	9-5	14-9	19-6	24-10	Note a	9-5	14-4	18-2	22-3	25-9
	Spruce-Pine-Fir	#2	9-5	14-9	19-6	24-10	Note a	9-5	14-4	18-2	22-3	25-9
	Spruce-Pine-Fir	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
16	Douglas Fir-Larch	SS	9-6	14-11	19-7	25-0	Note a	9-6	14-11	19-7	24-9	Note a
	Douglas Fir-Larch	#1	9-1	14-4	18-11	23-9	Note a	9-1	13-3	16-10	20-7	23-10
	Douglas Fir-Larch	#2	8-11	14-1	18-2	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Douglas Fir-Larch	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10
	Hem-Fir	SS	8-11	14-1	18-6	23-8	Note a	8-11	14-1	18-6	23-8	Note a
	Hem-Fir	#1	8-9	13-9	18-1	23-1	Note a	8-9	12-11	16-5	20-0	23-3
	Hem-Fir	#2	8-4	13-1	17-3	21-11	25-5	8-4	12-3	15-6	18-11	22-0
	Hem-Fir	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10
	Southern Pine	SS	9-4	14-7	19-3	24-7	Note a	9-4	14-7	19-3	24-7	Note a
	Southern Pine	#1	9-1	14-4	18-11	24-1	Note a	9-1	14-4	18-10	22-4	Note a
	Southern Pine	#2	8-11	14-1	18-6	23-2	Note a	8-11	13-0	16-10	20-1	23-7
	Southern Pine	#3	7-11	11-8	14-10	17-6	20-11	6-10	10-1	12-10	15-2	18-1
	Spruce-Pine-Fir	SS	8-9	13-9	18-1	23-1	Note a	8-9	13-9	18-1	23-0	Note a
	Spruce-Pine-Fir	#1	8-7	13-5	17-9	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Spruce-Pine-Fir	#2	8-7	13-5	17-9	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Spruce-Pine-Fir	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10

(continued)

TABLE 2308.10.3(2)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Roof Live Load = 20 pounds per square foot, Ceiling Not Attached to Rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 pounds per square foot					DEAD LOAD = 20 pounds per square foot				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas Fir-Larch	SS	8-11	14-0	18-5	23-7	Note a	8-11	14-0	18-5	22-7	Note a
	Douglas Fir-Larch	#1	8-7	13-6	17-9	21-8	25-2	8-4	12-2	15-4	18-9	21-9
	Douglas Fir-Larch	#2	8-5	13-1	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Douglas Fir-Larch	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5
	Hem-Fir	SS	8-5	13-3	17-5	22-3	Note a	8-5	13-3	17-5	22-3	25-9
	Hem-Fir	#1	8-3	12-11	17-1	21-1	24-6	8-1	11-10	15-0	18-4	21-3
	Hem-Fir	#2	7-10	12-4	16-3	20-0	23-2	7-8	11-2	14-2	17-4	20-1
	Hem-Fir	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5
	Southern Pine	SS	8-9	13-9	18-1	23-1	Note a	8-9	13-9	18-1	23-1	Note a
	Southern Pine	#1	8-7	13-6	17-9	22-8	Note a	8-7	13-6	17-2	20-5	24-4
	Southern Pine	#2	8-5	13-3	17-5	21-2	24-10	8-4	11-11	15-4	18-4	21-6
	Southern Pine	#3	7-3	10-8	13-7	16-0	19-1	6-3	9-3	11-9	13-10	16-6
	Spruce-Pine-Fir	SS	8-3	12-11	17-1	21-9	Note a	8-3	12-11	17-1	21-0	24-4
	Spruce-Pine-Fir	#1	8-1	12-8	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Spruce-Pine-Fir	#2	8-1	12-8	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Spruce-Pine-Fir	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5
24	Douglas Fir-Larch	SS	8-3	13-0	17-2	21-10	Note a	8-3	13-0	16-7	20-3	23-5
	Douglas Fir-Larch	#1	8-0	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Douglas Fir-Larch	#2	7-10	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Douglas Fir-Larch	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9
	Hem-Fir	SS	7-10	12-3	16-2	20-8	25-1	7-10	12-3	16-2	19-10	23-0
	Hem-Fir	#1	7-8	12-0	15-6	18-11	21-11	7-3	10-7	13-5	16-4	19-0
	Hem-Fir	#2	7-3	11-5	14-8	17-10	20-9	6-10	10-0	12-8	15-6	17-11
	Hem-Fir	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9
	Southern Pine	SS	8-1	12-9	16-10	21-6	Note a	8-1	12-9	16-10	21-6	Note a
	Southern Pine	#1	8-0	12-6	16-6	21-1	25-2	8-0	12-3	15-4	18-3	21-9
	Southern Pine	#2	7-10	12-3	15-10	18-11	22-2	7-5	10-8	13-9	16-5	19-3
	Southern Pine	#3	6-5	9-6	12-1	14-4	17-1	5-7	8-3	10-6	12-5	14-9
	Spruce-Pine-Fir	SS	7-8	12-0	15-10	20-2	24-7	7-8	12-0	15-4	18-9	21-9
	Spruce-Pine-Fir	#1	7-6	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Spruce-Pine-Fir	#2	7-6	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Spruce-Pine-Fir	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.9 N/m^2.

a. Span exceeds 26 feet in length. Check sources for availability of lumber in lengths greater than 20 feet.

TABLE 2308.10.4.1
RAFTER TIE CONNECTIONS[g]

RAFTER SLOPE	TIE SPACING (inches)	ROOF SPAN (FEET) 12	20	28	36
		Required number of 16d common ($3^1/_2''$ x 0.162″) nails[a,b] per connection[c,d,e,f]			
3:12	12	4	6	8	10
	16	5	7	10	13
	24	7	11	15	19
	32	10	14	19	25
	48	14	21	29	37
4:12	12	3	4	5	6
	16	3	5	7	8
	24	4	7	10	12
	32	6	9	13	16
	48	8	14	19	24
5:12	12	3	3	4	5
	16	3	4	5	7
	24	4	6	8	10
	32	5	8	10	13
	48	7	11	15	20
7:12	12	3	3	3	4
	16	3	3	4	5
	24	3	4	6	7
	32	4	6	8	10
	48	5	8	11	14
9:12	12	3	3	3	3
	16	3	3	3	4
	24	3	3	5	6
	32	3	4	6	8
	48	4	6	9	11
12:12	12	3	3	3	3
	16	3	3	3	3
	24	3	3	3	4
	32	3	3	4	5
	48	3	4	6	7

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.8 N/m^2.

a. 40d box (5″ × 0.162″) or l6d sinker ($3^1/_4''$ × 0.148″) nails are permitted to be substituted for 16d common ($3^1/_2''$ × 0.16″) nails.

b. Nailing requirements are permitted to be reduced 25 percent if nails are clinched.

c. Rafter tie heel joint connections are not required where the ridge is supported by a load-bearing wall, header or ridge beam.

d. When intermediate support of the rafter is provided by vertical struts or purlins to a load-bearing wall, the tabulated heel joint connection requirements are permitted to be reduced proportionally to the reduction in span.

e. Equivalent nailing patterns are required for ceiling joist to ceiling joist lap splices.

f. Connected members shall be of sufficient size to prevent splitting due to nailing.

g. Reserved.

2308.10.6 Blocking. Roof rafters and ceiling joists shall be supported laterally to prevent rotation and lateral displacement in accordance with the provisions of Section 2308.8.5.

2308.10.7 Engineered wood products. Prefabricated wood I-joists, structural glued-laminated timber and structural composite lumber shall not be notched or drilled except where permitted by the manufacturer's recommendations or where the effects of such alterations are specifically considered in the design of the member by a registered design professional.

2308.10.8 Roof sheathing. Roof sheathing shall be in accordance with Tables 2304.7(3) and 2304.7(5) for wood structural panels, and Tables 2304.7(1) and 2304.7(2) for lumber and shall comply with Section 2304.7.2.

2308.10.8.1 Joints. Joints in lumber sheathing shall occur over supports unless approved end-matched lumber is used, in which case each piece shall bear on at least two supports.

2308.10.9 Roof planking. Planking shall be designed in accordance with the general provisions of this code.

In lieu of such design, 2-inch (51 mm) tongue-and-groove planking is permitted in accordance with Table 2308.10.9. Joints in such planking are permitted to be randomly spaced, provided the system is applied to not less than three continuous spans, planks are center matched and end matched or splined, each plank bears on at least one support, and joints are separated by at least 24 inches (610 mm) in adjacent pieces.

2308.10.10 Wood trusses. Wood trusses shall be designed in accordance with Section 2303.4.

2308.10.11 Attic ventilation. For attic ventilation, see Section 1203.2.

2308.11 Additional requirements for conventional construction in Seismic Design Category B or C. Reserved.

2308.11.1 Number of stories. Reserved.

2308.11.2 Concrete or masonry. Reserved.

2308.11.3 Framing and connection details. Reserved.

2308.11.3.1 Anchorage. Reserved.

2308.11.3.2 Stepped footings. Reserved.

2308.11.3.3 Openings in horizontal diaphragms. Reserved.

2308.12 Additional requirements for conventional construction in Seismic Design Category D or E. Reserved.

TABLE 2308.10.9
ALLOWABLE SPANS FOR 2-INCH TONGUE-AND-GROOVE DECKING

SPAN[a] (feet)	LIVE LOAD (pound per square foot)	DEFLECTION LIMIT	BENDING STRESS (f) (pound per square inch)	MODULUS OF ELASTICITY (E) (pound per square inch)
Roofs				
4	20	1/240 1/360	160	170,000 256,000
	30	1/240 1/360	210	256,000 384,000
	40	1/240 1/360	270	340,000 512,000
4.5	20	1/240 1/360	200	242,000 305,000
	30	1/240 1/360	270	363,000 405,000
	40	1/240 1/360	350	484,000 725,000
5.0	20	1/240 1/360	250	332,000 500,000
	30	1/240 1/360	330	495,000 742,000
	40	1/240 1/360	420	660,000 1,000,000
5.5	20	1/240 1/360	300	442,000 660,000
	30	1/240 1/360	400	662,000 998,000
	40	1/240 1/360	500	884,000 1,330,000
6.0	20	1/240 1/360	360	575,000 862,000
	30	1/240 1/360	480	862,000 1,295,000
	40	1/240 1/360	600	1,150,000 1,730,000
6.5	20	1/240 1/360	420	595,000 892,000
	30	1/240 1/360	560	892,000 1,340,000
	40	1/240 1/360	700	1,190,000 1,730,000
7.0	20	1/240 1/360	490	910,000 1,360,000
	30	1/240 1/360	650	1,370,000 2,000,000
	40	1/240 1/360	810	1,820,000 2,725,000

(continued)

TABLE 2308.10.9–continued
ALLOWABLE SPANS FOR 2-INCH TONGUE-AND-GROOVE DECKING

SPAN[a] (feet)	LIVE LOAD (pound per square foot)	DEFLECTION LIMIT	BENDING STRESS (*f*) (pound per square inch)	MODULUS OF ELASTICITY (*E*) (pound per square inch)
Roofs				
7.5	20	1/240 1/360	560	1,125,000 1,685,000
	30	1/240 1/360	750	1,685,000 2,530,000
	40	1/240 1/360	930	2,250,000 3,380,000
8.0	20	1/240 1/360	640	1,360,000 2,040,000
	30	1/240 1/360	850	2,040,000 3,060,000
Floors				
4 4.5 5.0	40	1/360	840 950 1,060	1,000,000 1,300,000 1,600,000

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kN/m^2, 1 pound per square inch = 0.00689 N/mm^2.

a. Spans are based on simple beam action with 10 pounds per square foot dead load and provisions for a 300-pound concentrated load on a 12-inch width of decking. Random layup is permitted in accordance with the provisions of Section 2308.10.9. Lumber thickness is $1^1/_2$ inches nominal.

SECTIONS 2309 - 2313
RESERVED

SECTION 2314
HIGH-VELOCITY HURRICANE ZONES

2314.1 Design. Wood members and their fastenings shall be designed to comply with this code by methods based on rational analysis or approved laboratory testing procedures, both performed in accordance with fundamental principles of theoretical and applied mechanics.

2314.2 Workmanship. Wood members shall be framed, anchored, tied and braced to develop the strength and rigidity necessary for the purposes for which they are used and to resist the loads imposed as set forth in this code. Wood construction shall be in conformance with the tolerances, quality and methods of construction as prescribed by the standards in Chapter 35 of this code.

2314.3 Fabrication.

2314.3.1 Preparation, fabrication and installation of wood members and the glues, connectors and mechanical devices for fastening shall conform to good engineering practice.

2314.3.2 Any person desiring to manufacture or fabricate wood truss assemblies shall obtain a certificate of competency from the authority having jurisdiction.

2314.4 The following Standards, as set forth in Chapter 35 of this code, are hereby adopted for the design and quality of wood members and their fastenings:

2314.4.1 American Hardboard Products Association 887-B Wilmette Road,
Palatine, IL 60067 AHA

1. Basic Hardboard ANSI/AHA A135.4-1982
2. Prefinished Hardboard Paneling ANSI/AHA A135.5-1982
3. Hardboard Siding ANSI/AHA A135.6-1990
4. Cellulosic Fiberboard ANSI/AHA A194.1-1985
5. Recommended Product and Application Specification - Structural Insulating RoofDeck, I.B. Spec. No. 1
6. Recommended Product and Application Specification - $^1/_2$ inch Fiberboard Nail-Base-Sheathing I.B. Spec. No. 2
7. Recommended Product and Application Specification - $^1/_2$ inch Intermediate Fiberboard Sheathing I.B. Spec. No. 3

2314.4.2 American Institute of Timber Construction 333 West Hampden Avenue, Englewood, CO 80110 AITC

1. Typical Construction Details, AITC 104
2. Code of Suggested Practices, AITC 106
3. Standard for Heavy Timber Construction, AITC 108
4. Standard for Preservative Treatment for Structural Glued Laminated Timber, AITC 109
5. Standard Appearance Grades for Structural Glued Laminated Timber, AITC 110
6. Standard for Tongue and Groove Heavy Timber Roof Decking, AITC 112
7. Standard for Dimensions of Glued Laminated Structural Members, AITC 113
8. Standard Specifications for Structural Glued Laminated Timber of Softwood Species, AITC 117
9. Standard Specifications for Hardwood Glued Laminated Timber, AITC 119
10. Technical Report No. 7, Calculation of Fire Resistance of Glued Laminated Timber
11. Structural Glued Laminated Timber, ANSI/AITC A190.1

2314.4.3 APA The Engineered Wood Association (Formerly APA American Plywood Association) P.O. Box 11700, Tacoma, WA 98411

1. APA Design Construction Guide, Residential and Commercial E30D
2. Plywood Design Specification Y510J
3. Plywood Design Specification-Design and Fabrication of Plywood Beams Supplement No. 1 S811
4. Plywood Design Specification-Design and Fabrication of Plywood Beams Supplement No. 2 S812
5. Plywood Design Specification-Design and Fabrication of Plywood Stressed-Skin Panels Supplement No. 3 U813
6. Plywood Design Specifications-Design and Fabrication of Plywood Sandwich Panels Supplement No. 4 U814
7. Plywood Design Specifications-Design and Fabrication of All-Plywood Beams. Supplement No. 5 H815
8. Plywood Folded Plate, Laboratory Report 21 V910
9. APA Design/Construction Guide Diaphragms L350
10. Performance Standards and Policies for Structural-Use Panels PRP-108
11. 303 Siding Manufacturing Specifications B840

2314.4.4 American Society for Testing Materials 1916 Race Street, Philadelphia, PA 19103-1187 ASTM

1. Standard Test Methods for Mechanical Fasteners in Wood D 1761
2. Accelerated Weathering on Fire-Retardant Treated Wood for fire testing D 2898
3. Surface Burning Characteristics of Building Materials E 84
4. Hygroscopic Properties of Fire-Retardant Wood and Wood-Base Products D 3201
5. Standard Specifications for Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems D 3498

2314.4.5 American Wood Preservers Association P.O. Box 5283, Springfield, VA 22150 AWPA

1. All Timber Products - Pressure Treatment (General Requirements) C1
2. Lumber, Timbers, Bridge Ties & Mine Ties Pressure Requirements C2
3. Piles - Pressure Treatment C3
4. Poles - Pressure Treatment C4
5. Care of Pressure Treated Wood Products M4
6. Posts - Pressure Treatment C5
7. Crossties and Switch Ties -Pressure Treatment C6
8. Incised (Red, White & Alaska Yellow Cedar) Poles Butts Thermal Treatment C7
9. Poles (Western Red & Alaska Yellow Cedar) Full Length Thermal Treatment C8
10. Plywood - Pressure Treatment C9
11. Poles (Lodgepole Pine) Full Length Thermal Treatment C10
12. Wood Blocks for Floors & Platforms Pressure Treatment C11
13. Wood for Highway Construction Pressure Treatment C14
14. Wood used on Farms - Pressure Treatment C16
15. Piles and Timbers in Marine Construction Pressure Treatment C18
16. Structural Lumber - Fire Retardant -Pressure Treatment C20
17. Lumber and Plywood for Permanent Wood Foundations C22
18. Pole Building Construction - Pressure Treatment C Section 23
19. Crossarms - Pressure Treatment C25
20. Crossarms - Non-Pressure Treatment C26
21. Structural Glued Laminated Members & Laminations Before Gluing Pressure Treatment C28
22. Lumber to be Used for the Harvesting, Storage and Transportation of Food Stuffs - Pressure Treatment C29

2314.4.6 National Institute for Standards and Technology Standard Development Services Section, Standards Application and Analysis Division, Washington, D.C. 20234 NIST

1. Mat-Formed Particleboard CS236
2. Structural Glued Laminated Timber PS56
3. Construction and Industrial Plywood PS1
4. American Softwood Lumber Standard PS20
5. Performance Standard for Wood Based Structural Use Panels PS2{*}
   {*} All wood-based structural panels except plywood shall have Product Approval and shall be tested in accordance with High-Velocity Hurricane Zone Testing Protocols.

2314.4.7 American Forest and Paper Association, 1111 19 Street NW, Washington, D.C. 20036

1. ANSI/AF&PA National Design Specification for Wood Construction, 2001
2. ANSI/AF&PA Design Values for Wood Construction, 2001
3. Wood Structural Design Data, 1992
4. Span Tables for Joists and Rafters, 1993
5. Working Stresses for Joists and Rafters, 1993
6. Wood Construction Data No. 1, Details for Conventional Wood Frame Construction, 2001
7. Wood Construction Data No. 4, Plank-and-Beam Framing for Residential Building, 1989
8. Wood Construction Data No. 5, Heavy Timber Construction Details, 1989
9. Wood Construction Data No. 6, Design of Wood Frame Structures for Permanence, 1988

10. Technical Report No. 7, The Permanent Wood Foundation System, 1987
11. ANSI/AF&PA WFCM-2001, Wood Frame Construction Manual for one and Two-Family Dwellings, 2001
12. All-Weather Wood Foundation System, Design, Fabrication, Installation Manual, 1987
13. Technical Report No. 7, All-Weather Wood Foundation System Basic Requirements with Supplements, 1987

2314.4.8 Timber Company, Inc. 2402 Daniels Street, Madison, WI 53704

TECO Performance Standards and Policies for Structural use Panels. PRP-133

2314.4.9 Truss Plate Institute.
218 N. Lee Street, Suite 312, Alexandria, VA 22314

1. *National Design Standard for Metal Plate Connected Wood Truss Construction* (Excluding Chapter 2).
2. Building Component Safety Information (BCSI 1) *Guide to Good Practice for Handling, Installing & Bracing of Metal Plate Connected Wood Trusses* [A joint publication with the Wood Truss Council of America (WTCA)].

2314.4.10 Underwriters Laboratories, Inc.
333 Pfingsten Road, Northbrook, IL 60062

Test Methods for Fire Resistance of UL-790 Roof Covering Materials

SECTION 2315
HIGH-VELOCITY HURRICANE ZONES — QUALITY

2315.1 Identification. All lumber used structurally, including end-jointed lumber, shall be identified by the grade mark of a lumber grading or inspection bureau or agency approved by the Board of Review of the American Lumber Standards Committee or the Canadian Lumber Standards Administrative Board: except that precut material, rough-sawn lumber and lumber thicker than 2 inches (51 mm) may be covered by a certificate of inspection in lieu of grade marking. The glued joints in end-jointed lumber, when used for load supporting purposes, shall be certified to be in accordance with the appropriate grading rules.

2315.1.1 Structural glued-laminated timber shall be manufactured and identified as required in ANSI/AITC 190.1 as adopted in Section 2314.4.

2315.1.2 All wood-based structural panels used structurally, including siding, roof sheathing, wall sheathing, floor sheathing, diaphragms and built-up members, shall be identified for grade and exposure level by the grade stamp of an approved testing and grading agency indicating conformance with PS-1, PS-2, APA PRP-108 or TECO PRP-133 as adopted in Section 2314.4.

2315.1.3 Wood shingles and/or shakes shall be identified by the grademark of an approved grading or inspection bureau or agency.

2315.1.4 Fiberboard for its various uses shall conform to ANSI/AHA A 194.1.

2315.1.5 Hardboard shall conform to AHA Standards as adopted in Section 2314.4, and shall be identified as to classification.

2315.1.6 Particleboard shall conform to the *Mat-Formed Particleboard Standard,* NIST CS Section 236, as adopted in Section 2314.4.6, and shall be identified by the grade mark or certificate of inspection issued by an approved agency.

2315.1.7 All lumber and wood-based structural panels required to be fire retardant treated shall bear permanent identification showing the fire performance rating thereof issued by an approved testing agency having a follow-up service. When exposed to the weather the material shall be permanently identified as suitable for such use in accordance with Section 2327.4. When exposed to sustained high humidity, the material shall be permanently identified as a low hygroscopic type suitable for interior use. Allowable design values, including connection design values, for lumber, glued laminated timber and wood-based structural panels, pressure treated with fire retardant chemicals shall be obtained from the company providing the treatment and redrying services. Listing of allowable design values shall be submitted and approved by the certification agency.

2315.1.8 All lumber, sawn timber, wood-based structural panels and poles supporting permanent structures and required by this code to be pressure treated and as described in the AWPA standards shall bear the quality mark of an approved inspection agency which maintains continued supervision, testing and inspection over the product. Agencies shall be accredited in accordance with the procedures of the American Lumber Standard (PS 20) or approved equivalent.

2315.1.9 Pressure-treated poles shall be branded in accordance with AWPA Standard M6 at the treating facility.

2315.1.10 The quality mark shall contain, as a minimum, the following information:

1. The treating company and plant location.
2. The AWPA standard to which the product is treated.
3. The trademark of an approved inspection agency which maintains continued supervision, testing and inspection over the quality of the product as described in the AWPA standards.
4. The preservative used.
5. The amount of retention of the chemical per cubic foot of wood.
6. If applicable, the method of drying after treatment.
7. The purpose for which the wood has been treated: ground contact, above ground or foundation.

   Exception: When the size of individual pieces, e.g. lumber less than 1 inch (25 mm) in nominal thickness, or lumber less than nominal 1inch by 5 inches (25 mm by 127 mm) or 2 inches by 4 inches (25 mm by 127 mm), or lumber 36 inches (914 mm) and shorter, except that $^{5}/_{4}$ by 4 shall be quality marked, prevents application of full legible marks, the quality mark shall be applied by stamping the faces of exterior pieces or by end labeling not less than 2 percent of the pieces of a bundled unit.

2315.1.11 All wood-based structural panels, including those made of fiberboard, hardboard and particleboard shall have Product Approval. Product Approval shall be given upon certification by an approved independent testing laboratory that the product:

1. Complies with the applicable standards set forth above.
2. The product complies with the manufacturer's published design properties before and after a wet-dry, wet-dry cycle.
3. The product when tested dry maintains a safety factor of 2:1 and when tested after the cycles specified in Section 2315.1.11(2) above maintains a safety factor of 1.5:1. Testing shall be as specified in the testing protocol.

2315.2 Wood-based structural panels permanently exposed in outdoor locations shall be rated for exterior use. When used for roof sheathing exposed to the outdoors on the underside or used structurally for wall, floor or roof cladding or for diaphragms, the panels shall be rated for Exposure 1 or exterior use.

2315.3 All lumber 2 inches (51 mm) or less in thickness shall contain not more than 19 percent moisture at the time of permanent incorporation in a building or structure and/or at the time of treatment with a wood preservative.

2315.4 Grade and species.

2315.4.1 All structural wood members not limited by other sections of this chapter shall be of sufficient size and capacity to carry all loads as required by the high-velocity hurricane provisions of Chapter 16 without exceeding the allowable design stresses specified in the *National Design Specification for Wood Construction* and in compliance with Section 2317.

2315.4.2 Lumber boards used for floor and roof sheathing shall be in accordance with Table 2315.4.2

TABLE 2315.4.2
MINIMUM GRADE REQUIREMENTS: BOARD GRADES

FLOOR OR ROOF SHEATHING	GRADING RULES
Utility	NLGA, WCLIB or WWPA
No. 4 Common or Utility	NLGA, WCLIB, WWPA, NHPMA or NELMA
No. 3	SPIB
Merchantable	RIS

SECTION 2316
HIGH-VELOCITY HURRICANE ZONES — SIZES

2316.1 Sizes of lumber, structural glued-laminated timber and plywood and other wood-based structural panels referred to in this code are nominal sizes.

2316.2 Computations to determine the required sizes of members shall be based on net dimensions (actual sizes).

SECTION 2317
HIGH-VELOCITY HURRICANE ZONES — UNIT STRESSES

2317.1 General.

2317.1.1 Lumber used for joists, rafters, trusses, columns, beams and/or other structural members shall be of no less strength than No. 2 grade of Southern Pine, Douglas Fir-Larch, Hem-Fir or Spruce-Pine-Fir. Joists and rafters shall be sized according to AF&PA Span Tables for Joists and Rafters adopted in Section 2314.4.

2317.1.2 Lumber used for studs in exterior walls and interior bearing walls shall be of no less strength than stud grade of Southern Pine, Douglas Fir-Larch, Hem-Fir or Spruce-Pine-Fir and capable of resisting all loads determined in accordance with Chapter 16 (High-Velocity Hurricane Zones). The unbraced height of the wall shall be no more than 8 feet 6 inches (2.6 m) (including top and bottom plates). Heights may be increased where justified by rational analysis prepared by a registered professional engineer or registered architect proficient in structural design.

2317.1.3 Lumber used for studs in interior non-bearing walls shall have a modulus of elasticity of no less than 0.9×10^6 pounds per square inch.

2317.1.4 The designer shall specify on the design drawings the size, spacing, species and grade of all load supporting members.

2317.2 Allowable stress design value may be modified for repetitive, duration, etc., factors where design is by a registered professional engineer or registered architect proficient in structural design or where such modified values are reflected in the tables of the standards in Section 2314.4.

SECTION 2318
HIGH-VELOCITY HURRICANE ZONE — VERTICAL FRAMING

2318.1 Studs in bearing and exterior walls. Studs in walls framing over 8 feet 6 inches (2.6 m) (including top and bottom plates) or supporting floor and roof loads shall be designed by rational analysis prepared by a registered professional engineer or registered architect proficient in structural design.

2318.1.1 Minimum size. Studs shall be not less than 2 inch by 6 inch for exterior walls or 2 inch by 4 inch (51 mm by 102 mm) for interior bearing or load resisting walls unless designed by rational analysis by a registered professional engineer or registered architect proficient in structural design.

2318.1.2 Spacing. Studs shall be spaced not more than 16 inches (406 mm) on center unless designed by rational analysis as a system of columns and beams by a registered professional engineer or registered architect proficient in structural design.

2318.1.3 Placing.

2318.1.3.1 Studs in exterior and bearing walls shall be placed with the longer dimension perpendicular to the wall.

2318.1.3.2 Studs in exterior walls and in bearing walls shall be supported by foundation plates, sills, or girders or floor framing directly over supporting walls or girders. Stud bearing walls when perpendicular to supporting joists may be offset from supporting walls or girders not more than the depth of the joists unless such joists are designed for the extra loading conditions.

2318.1.3.3 Stud walls framing into base plates of exterior walls and interior bearing walls resting on masonry or concrete shall be anchored past the plate to the masonry or concrete, or shall be anchored to a sill plate which is anchored in accordance with Section 2318.1.4.1 when the net wind uplift is up to 300 pounds per foot (4378 N/m).

2318.1.4 Sills and/or base plates.

2318.1.4.1 Sills and/or base plates, where provided in contact with masonry or concrete, shall be of an approved durable species or be treated with an approved preservative and shall be attached to the masonry or concrete with $^1/_2$ inch (13 mm) diameter bolts with oversized washer spaced not over 2 feet (610 mm) apart and embedded not less than 7 inches (178 mm) into a grout filled cell of masonry or into concrete. Base plates shall be placed in a recess $^3/_4$ inch (19 mm) deep and the width of the base plate at the edge of a concrete slab, beam/slab or any other type of construction which uses a masonry surface or concrete slab, or be provided with an alternate waterstop method as approved by the building official. Alternate methods of anchorage may be designed by rational analysis by a registered professional engineer or a registered architect proficient in structural design.

2318.1.4.2 Where the base plate of a bearing wall is supported on joists or trusses running perpendicular to the wall and the studs from the wall above do not fall directly over a joist or truss, a double base plate or a single base plate supported by a minimum 2 inch by 4 inch (51 mm by 102 mm) inset ribbon shall be used to support the upper stud wall.

2318.1.5 Top plates.

2318.1.5.1 The top plate of stud bearing walls shall be doubled and lapped at each intersection of walls and partitions.

2318.1.5.2 Joints shall be lapped not less than 4 feet (1219 mm).

2318.1.6 Corners. Corners of stud walls and partitions shall be framed solid by not less than three studs.

2318.1.7 Splicing. Studs, other than end-jointed lumber, shall be spliced only at points where lateral support is provided.

2318.1.8 Framing types.

2318.1.8.1 Wood framing may be any one, or a combination of, the following types: platform, balloon, plank and beam or pole type.

2318.1.8.2 Exterior stud walls of two-story buildings shall be balloon-framed with studs continuous from foundation to second floor ceiling and with second floor joists supported as indicated in Section 2319.3.3. Gable end walls in wood frame buildings shall be balloon framed with studs continuous from foundation to roof.

Exception: Platform framing is allowed in buildings over one story in height provided an additional mandatory inspection for floor level connectors is made before the framing/firestopping inspection. Gable end walls shall be balloon framed with studs continuous from top floor to roof.

2318.1.9 Notching.

2318.1.9.1 Studs that carry loads in excess of 75 percent of their capacity shall not be notched or cut.

2318.1.9.2 Studs that carry loads 75 percent or less of their capacity may be notched to one-third of the depth without limit of the number of consecutive studs.

2318.1.10 Pipes in walls.

2318.1.10.1 Stud walls and partitions containing pipes shall be framed to give proper clearance for the piping.

2318.1.10.2 Where walls and partitions containing piping are parallel to floor joists, the joists shall be doubled and may be spaced to allow vertical passage of pipes.

2318.1.10.3 Where vertical pipe positions necessitate the cutting of plates, a metal tie not less than 1 inch by $^1/_8$ inch (25 mm by 3 mm) shall be placed on each side of the plate across the opening and nailed with not less than two 16d or three 8d nails at each end.

2318.1.11 Headers.

2318.1.11.1 All headers in bearing walls shall be designed by rational analysis.

2318.1.11.2 Headers or lintels over stud wall openings shall have not less than nominal 2-inch (51 mm) bearings.

2318.1.12 Studs joining masonry or reinforced concrete walls. Where stud walls or partitions join masonry or concrete walls, such studs shall be secured against lateral movement by bolting to the masonry or concrete with $^1/_2$ inch (13 mm) diameter anchor bolts with oversized washer spaced not more than 4 feet (1219 mm) apart and embedded not less than 5 inches (127 mm) into a grout filled cell or into concrete or as designed by a registered professional engineer or registered architect proficient in structural design using rational analysis.

2318.1.13 Wind bracing. Exterior stud walls shall be effectively wind-braced in accordance with Section 2322.3.

Such bracing shall be designed by a registered professional engineer or registered architect proficient in structural design.

2318.1.14 The intermixing of wall framing described in this chapter with other types of structural wall systems as provided in this code shall not be permitted unless such wall framing and connections are designed by a registered professional engineer or registered architect proficient in structural design.

2318.1.15 Wall hung fixtures. Studs in bearing walls, exterior walls and nonbearing partitions supporting wall hung plumbing fixtures and wall cabinets shall be not less than 2x4, where spaced not more than 16 inches (406 mm) on center or, not less than 2 inch by 6 inch (51 mm by 152 mm), where spaced not more than 24 inches (610 mm) on center.

2318.1.15.1 A minimum 2-inch by 4-inch (51 mm by 104 mm) horizontal wood member, securely fastened to not less than two such studs, shall be installed for the attachment of each wall hung plumbing fixture and wall cabinet.

2318.2 Interior nonbearing partitions.

2318.2.1 Studs in interior nonbearing partitions shall be of not less than 2 inch by 4 inch (51 mm by 104 mm) spaced not more than 24 inches (610 mm) o.c.

2318.2.2 Interior nonbearing stud partitions may have a single top plate.

2318.2.3 Headers over openings not exceeding 4 feet (1219 mm) in width may be of 2-inch (51 mm) nominal thickness placed flat and end-nailed through the studs with no solid bearing provided.

2318.2.4 Studs in interior nonbearing partitions shall be placed with the longer dimension perpendicular to the partition.

2318.2.5 Stud partitions subject to frequent wetting shall be of pressure treated wood or shall be protected with 15-pound asphalt-saturated felt, or by other approved design methods.

2318.2.6 Wardrobe units serving as nonbearing partitions, prefabricated or partially prefabricated may be of 2-inch by 2-inch (51 mm by 51 mm) studs spaced not farther apart than 16 inches (406 mm) provided there is a wood-based structural panel skin-glued or nailed to the studs.

2318.3 Columns and posts.

2318.3.1 Columns and posts shall be framed to true end bearing, shall be securely anchored against lateral and vertical forces, and shall be designed by a registered professional engineer or registered architect proficient in structural design.

2318.3.2 The bottom of columns and posts shall be protected against deterioration by an approved product or method.

2318.3.3 Columns and posts shall be spliced only in regions where lateral support is adequately provided about both axes and is designed by rational analysis. Such design shall be prepared, signed and sealed by a registered professional engineer or registered architect proficient in structural design.

2318.3.4 Design dimensions of columns and posts shall not be reduced by notching, cutting or boring.

SECTION 2319
HIGH-VELOCITY HURRICANE ZONES – HORIZONTAL FRAMING

2319.1 Size.

2319.1.1 The minimum size of joists and rafters shall be as set forth in Section 2317.

2319.1.2 The design of horizontal framing other than joists and rafters shall be as set forth in Section 2317.1.1.

2319.1.3 Horizontal wood members independently supporting a suspended ceiling shall be not less than 2-inch by 4-inch (51 mm by 102 mm) and hangers shall be not less than the equivalent of 1-inch by 4-inch (25 mm by 102 mm) wood members providing proper nailing.

2319.2 Spacing. Joists and rafters, where a plaster ceiling is directly supported, shall comply with Section 2507.2.3.

2319.3 Bearing.

2319.3.1 Joists and rafters shall have not less than three inches of bearing, on wood, metal, grout filled masonry or concrete except as provided in Sections 2319.3.2, 2319.3.3 and 2319.3.4.

2319.3.2 Masonry and concrete.

2319.3.2.1 Joists and rafters may bear on and be anchored by steel strap anchor embedded into a grout filled cell of the masonry or reinforced concrete, as described in Sections 2321.5.1, to a wood plate provided such wood plate is of an approved durable species or pressure treated with an approved preservative and such plate shall be not less than 2 inch by 4 inch (51 mm by 102 mm) and attached as per Section 2318.1.4.1. The net uplift on the plate shall be limited to 300 pounds per foot (4378 N/m).

2319.3.2.2 Joists and rafters may bear on a Product Approved channel-shaped metal saddle and fastened to the masonry by a steel strap anchor embedded into a grout filled cell of the masonry or concrete.

2319.3.2.3 Joists and rafters may bear on masonry, provided that each joist or rafter in contact with masonry is of an approved durable species or pressure treated with an approved preservative and anchored as in Section 2319.3.2.2 above.

2319.3.3 Floor joists may butt into a header beam if effectively toenailed and if an approved metal hanger providing not less than 3 inches (76 mm) of bearing transmits the vertical load to the top of the header, provided, however, that approved devices or other approved means of support may be used in lieu of such bearing. All hangers and devices shall have Product Approval.

2319.3.4 Ceiling joists may butt into a header beam, as set forth for floor joists, or approved devices or other approved means of support may be used in lieu of such bearing. All devices shall have Product Approval.

2319.3.5 In lieu of the above, bearing and anchorage may be designed by rational analysis by a registered professional engineer or registered architect proficient in structural design.

2319.4 Splicing. Horizontal members shall not be spliced between supports except that properly designed splices or approved end-jointed lumber may be used.

2319.5 Notching and boring.

2319.5.1 Unless local unit stresses are calculated on the basis of reduced size, wood members in bending shall not be cut, notched or bored except as provided in Sections 2319.5.1.1 and 2319.5.1.2.

2319.5.1.1 Notches may be cut in the top or bottom not deeper than one-sixth of the depth not longer than one-third of the depth of the member and shall not be located in the middle one-third of the span. Where members are notched at the ends, over bearing points, the notch depth shall not exceed one-fourth the member depth.

2319.5.1.2 Holes may be bored in the middle one-third of the depth and length and not larger than one-sixth of the depth. Space between any two holes in the same joist shall be not less than the depth of the joist.

2319.5.2 Where necessary to run service pipes in the space between the ceiling and floor larger than can be accommodated by the above provision, such ceilings shall be furred or provision made for headers or beams and/or for changing direction of the joists where the design permits.

2319.6 Openings.

2319.6.1 Joists shall be doubled adjacent to openings where more than one joist is cut out or shall be so increased in size or number as may be needed to meet the stress requirements.

2319.6.2 Headers shall be of the same size as the joists and where supporting more than one joist shall be double members.

2319.6.3 Headers shall be supported by approved metal hangers or ledgers or other approved members.

2319.7 Wood entering masonry or reinforced concrete.

2319.7.1 Wood joists, beams or girders which frame into masonry or reinforced concrete shall have a minimum of $^1/_2$-inch (12.7 mm) air space at the top, end and sides or shall be preservative pressure treated or of an approved durable species.

2319.7.2 Where masonry extends above such wood members, joists shall be fire-cut so the top edge does not enter the masonry more than 1 inch (25 mm) or shall be provided with wall plate boxes of self-releasing type or approved hangers.

2319.7.3 Where joists enter a masonry wall required to be fire resistive, such joists shall be separated from the opposite side of the wall by at least 4 inches (102 mm) of solid masonry.

2319.8 Floor joists.

2319.8.1 Floor joists under all walls or partitions parallel to the joists shall be doubled.

2319.8.2 Doubled joists may be separated not more than 6 inches (152 mm).

2319.8.3 Floor joists supporting concrete or grout for tile floors shall have a maximum spacing of 12 inches (305 mm).

2319.9 Ceiling joists.

2319.9.1 In buildings with pitched roofs the ceiling joists, where practicable, shall be nailed to the rafters and shall be designed to carry all imposed loads including but not limited to lateral thrust.

2319.9.2 Ceiling joists spanning more than 10 feet (3 m) shall be laterally supported at midspan.

2319.9.3 Ceiling joists shall not be used to support rafter loads unless the joists and connections are properly designed for the total load being imposed.

2319.10 Roof framing. The permit documents shall include roof framing plans showing spacing and spans of all roof members indicating any fabricated elements to be designed and furnished by others and shall include the details for support and bearing of the roof structural system, for the permanent cross/lateral/diagonal bracing and anchorage required to resist dead, live and wind loads as set forth in Chapter 16 (High-Velocity Hurricane Zones). The framing plans shall also indicate the uplift forces applied on the roof, sheathing type, thickness and nailing requirements for the sheathing. The roof framing plans shall be prepared by and bear the sign and seal of, a registered professional engineer or registered architect of record proficient in structural design.

2319.11 Roof joists. Roof joists may cantilever over exterior walls as limited by the allowable stress, but the length of such cantilever shall not exceed one-half the length of the portion of the joist inside the building; and where the cantilever of tail joists exceeds 3 feet (914 mm), the roof joist acting as a header shall be doubled.

2319.12 Roof rafters.

2319.12.1 Hip rafters, valley rafters and ridge boards shall be provided and shall be not less in size than the largest rafter framing thereto nor less than required to support the loads.

2319.12.2 Collar ties.

2319.12.2.1 Collar ties and their connections shall be provided to resist the thrust of rafters and shall be designed by a registered engineer or registered architect proficient in structural design.

2319.12.2.2 Collar ties shall not be required if the ridge is designed as a supporting beam. Such design shall be done by a registered professional engineer or registered architect proficient in structural design.

2319.12.2.3 Ceiling joists may serve as collar ties when properly designed by a registered professional engineer or registered architect proficient in structural design.

2319.12.3 The actual roof and ceiling dead loads may be used to resist uplift loads, but the maximum combined dead load used to resist uplift loads shall not exceed 10 pounds per square foot (479 Pa).

2319.13 Heavy timber construction. Heavy timber construction of floors or roofs shall comply with the standards in Section 2314.4. All heavy timber construction shall be designed by a registered professional engineer or registered architect proficient in structural design to withstand the loads required in Chapter 16 (High-Velocity Hurricane Zones).

2319.14 Vertically laminated beams. Vertically laminated built-up beams shall be designed and made up of members continuous from bearing to bearing.

2319.15 Glued-laminated members. Glued-laminated members shall be designed to comply with applicable AITC standards adopted by this code.

2319.16 Stair stringers.

2319.16.1 Stair stringers shall, where practicable, be framed to provide 4 inches (102 mm) of bearing at the ends.

2319.16.2 Where it is not practicable to provide such bearing, the stringers shall be hung in steel hangers of approved type.

2319.16.3 Stair stringers shall not be notched or cut in the effective area.

2319.16.4 Two stringers shall be provided for each flight of stairs no more than 36 inches (914 mm) in width, and an additional stringer shall be provided for each 18 inches (457 mm) of additional stair width except for public stairs where the number of stringers shall be determined by rational analysis by a registered professional engineer or registered architect proficient in structural design.

2319.17 Wood trusses.

2319.17.1 Trussed rafters. Trussed rafters shall be designed by methods admitting of rational analysis by a registered professional engineer or registered architect proficient in structural design based on the standards set forth in Section 2314.4.

2319.17.1.1 Where steel is used for connecting wood members, such connectors shall be not less than 20 U.S. gage and shall be protected with a zinc coating conforming to ASTM A 361 set forth in Chapter 35 of this code. Connectors shall have Product Approval or shall be designed by methods admitting of rational analysis by a registered professional engineer or registered architect proficient in structural design.

2319.17.1.2 Where a ceiling is to be attached directly to the underside of trusses, the trusses shall be laterally braced with continuous 1-inch by 4-inch (25 mm by 102 mm) members nailed with 8d common nails to the upper side of the bottom chord at panel points but not to exceed 10 feet (3 m) apart. This lateral bracing shall be restrained at each end and at 20-foot (6 m) intervals. Drywall may be considered a rigid ceiling in enclosed areas where it is protected from the elements. The drywall ceiling is not to be considered a ceiling diaphragm.

2319.17.1.3 Where a ceiling is to be attached to wood stripping which is nailed to the underside of the bottom chord of trusses with two-8d common nails at each intersection, stripping shall be not less than 1 inch by 3 inches (25 mm by 76 mm) spaced not more than 24 inches (610 mm) apart. Wood stripping may be replaced by furring channels. Furring channels shall be a minimum of $^7/_8$ inch (22 mm) hat-shaped channels weighing 287 pounds per 1000 lineal feet (41.4 kg per 100 m) with minimum based steel of 0.0179 inch (0.445 mm) and complying with ASTM C 645 attached to trusses with minimum two #6 1-$^1/_4$ inch (32 mm) screws per intersection. Said stripping or metal furring channels may serve also as the lateral bracing of the truss bottom chord so as to minimize the effects of buckling of the bottom chord when subjected to compressive stresses under reverse load conditions. In addition, the rigid ceiling that is created by this 1-inch by 3-inch (25 mm by 76 mm) stripping or metal furring channels must also be restrained from lateral movements, in accordance with the details provided by the architect or professional engineer of record.

Exception: Where fire-rated design assembly does not allow for this specific installation, see Section 2319.17.1.2

2319.17.1.4 Where a ceiling is attached to wood members suspended beneath trusses, the provisions of Section 2319.1 shall apply.

2319.17.2 Prefabricated wood trusses. Prefabricated wood trusses shall comply with this section.

2319.17.2.1 Design.

2319.17.2.1.1 Prefabricated wood trusses shall be designed by a registered professional engineer (delegated engineer) and fabricated in accordance with the *National Design Standard for Metal Plate Connected Wood Truss Construction of the Truss Plate Institute* (TPI). The truss system designer (delegated engineer) shall prepare the truss system shop drawings. Such shop drawings shall be submitted to the building official for review and approval. The shop drawings shall meet the following requirements:

1. All shop drawings shall be in conformity with the architect or engineer of record framing plans unless prior written approval is obtained from the architect or engineer of record. If reframing is approved, the architect or engineer of record shall resubmit revised framing plans to the building official after receiving updated plans from the delegated engineer showing all adjustments necessary to safely transmit all applied loads to the foundation.
2. Permanent bracing of individual truss members may be required on certain members of the trusses to prevent the members from buckling in the plane normal to the trusses (buckling in the narrow direction). This bracing shall be designed for both upward and downward loads and shall be shown on the individual truss drawings (truss engineering usually shown on $8^1/_2$-inch by 11-inch (216 mm by 279 mm)

sheets ("A" size drawings). The design of this bracing shall be the responsibility of the delegated engineer. The contractor shall be responsible for seeing that this bracing is properly installed. This bracing may be in the form of (but not limited) to "T" bracing of an individual member, or lateral bracing of a series of members common to a number of trusses. Where lateral bracing is used, this bracing shall be restrained against lateral movement, in accordance with details provided by the delegated engineer or by the architect or professional engineer of record. All details and sections required to show the size and connections of all secondary members will be supplied on the delegated engineering plans and shall show all framing, connections and bracing on one or more primary plans of minimum size 24 inches by 36 inches (610 mm by 914 mm).

3. A size $8^{1}/_{2}$-inches by 11-inches (216 mm by 279 mm) cut sheets showing individual member design shall also be furnished to the architect or engineer of record so that all gravity and uplift loads shown on these cut sheets can be transferred to the primary plans.
4. The size and location of all plates at each joint shall be shown on the truss design drawings.
5. The connection between trusses shall be detailed in the shop drawings. Hip sets shall be detailed in a manner to indicate all connections according to engineering drawings for the attachment of skewed members.
6. Truss design drawings shall indicate the support and minimum bearing of the roof structural system, the permanent cross/lateral bracing, bracing to transfer member buckling forces to the structure and all bracing and anchorage required to resist uplift and lateral forces.
7. Flat and floor trusses must be clearly marked so that they will be installed right side up. These marks must remain after the flooring, sheathing and insulation have been installed.

The intent of the above requirements is to provide all information on framing, connections and bracing on one composite set of plans approved by the architect or engineer of record to aid in the review, approval and field inspections for the portion of the property.

2319.17.2.1.2 Trusses shall be designed for wind loads per Chapter 16 (High-Velocity Hurricane Zones), uniformly distributed live, dead and concentrated loads, and such loads shall be indicated on the roof framing plans and the truss design drawings. Where a girder or truss is subjected to concentrated loads or any unusual loading condition, such conditions must be clearly indicated on the roof framing plans and on the truss design drawings. Where truss members have been cut, shifted or altered in any manner to meet construction needs or for any other reason, additional drawings and additional calculations must be prepared, signed and sealed by the truss designer (a Florida-delegated engineer). Such additional drawings and calculations must be approved by the engineer or architect of record and must be submitted to the building official for review and approval.

2319.17.2.1.3 Roof trusses shall be designed for a minimum live load of 30 psf (1436 Pa), a minimum dead load of 15 psf (718 Pa) on the top chord, and a minimum dead load of 10 psf (479 Pa) on the bottom chord; and wind loads per Chapter 16 of this code. Where the roof design is such that water is not directed to the interior of the roof and there are no parapets or other roof edge drainage obstructions, roof trusses with slopes of $1^{1}/_{2}$:12 or greater may be designed for a live load of 20 psf (958 Pa) and a minimum total load of 45 psf (2155 Pa). Adjustment of the allowable design stress for load duration shall be in accordance with *National Design Specification for Wood Construction* except that load duration factor for wind loads shall not exceed 1.33.

2319.17.2.1.4 The allowable deflection under live load for trusses shall not exceed span/360 for plastered ceilings, span/240 for unplastered finished ceilings, or span/180 for trusses without a ceiling.

2319.17.2.1.5 Flat roof trusses shall be designed for not less than the loads set forth in Section 2319.17.2.1.3 above, except that the dead load on the top chord may be taken as 10 psf (479 Pa) in lieu of 15 psf (718 Pa), and the total load reduced to 50 psf (2394 Pa). Adjustment of the allowable design stress for load duration shall be in accordance with *National Design Specification for Wood Construction* except that load duration factor for wind loads shall not exceed 1.33.

2319.17.2.1.6 Where gable end trusses are permitted in this code, they shall be designed for a minimum live load of 30 psf (1436 Pa) and a minimum dead load of 15 psf (718 Pa) on the top chord. The minimum load of 10 psf (479 Pa) on the bottom chord may be omitted where continuous support is provided. In addition, the gable end trusses shall be designed to sustain wind load as specified in Chapter 16 (High-Velocity Hurricane Zones) but not less than 30 psf (1436 Pa) perpendicular to the plane of the truss. Such trusses shall use a rationally designed system to resist lateral wind loads and be anchored to the substructure at intervals no greater than 4 feet (1219 mm) on center to resist the uplift forces and shall be designed to transfer the loads to the substructure. The design of the system used to resist the lateral loads imposed on the truss shall be prepared by the engineer or architect of record.

2319.17.2.1.7 When girders exceed two members and when girder reactions exceed the capacity of standard connectors or hangers, these reactions shall be shown on the drawings and the connection must be designed, signed and sealed by a registered professional engineer or registered architect proficient in structural design and such design shall be included as part of the shop drawings.

2319.17.2.1.8 All trusses shall be properly braced to act as a system. Such bracing shall be included as part of the design document.

2319.17.2.2 Materials and specifications.

2319.17.2.2.1 Trusses shall be fabricated applying the design values listed in the standard *Design Values for Wood Construction of the American Forest and Paper Association.*

2319.17.2.2.2 Top and bottom chords shall be of No. 2 Grade or better. Web members shall be of No. 3 Grade or better. A chord member is defined as the entire top or bottom truss member which may consist of shorter spliced pieces.

2319.17.2.2.3 For trusses spanning 20 feet (6 m) or less, the minimum percentage of grade-marked members among top and bottom chords shall be 50 percent.

2319.17.2.2.4 For trusses spanning more than 20 feet (6 m) the minimum percentage of grade-marked members among top and bottom chords shall be 75 percent, and there shall be a minimum of one marked web on each truss.

2319.17.2.2.5 All lumber shall be 2 inches by 4 inches (51 mm by 102 mm) nominal or larger, and no 2 inch (51 mm) nominal member shall be less in size than 1 $^1/_2$ inch (38 mm).

2319.17.2.2.6 The moisture content of all lumber used in wood truss fabrication shall not exceed 19 percent.

2319.17.2.2.7 Connector plates shall be not less than 20 gauge galvanized steel meeting ASTM A 653/A 653M or A 924/A 924M, and shall be identified by the manufacturer's stamp. The size and location of all plates shall be shown on the truss design drawings. Connectors shall have product approval.

2319.17.2.2.8 All connector plates over 3 inches (76 mm) and 25 percent of 3 inches (76 mm) or less, as per TPI standards, shall bear the name, logo or other markings, which clearly identify the manufacturer. Semiannually, plate manufacturers shall certify compliance with the provisions of Section 6 of the Truss Plate Institute, TPI, *National Design Standard for Metal Plate Connected Wood Truss Construction*, with respect to the grade of steel, thickness or gauge of material, and galvanizing to ASTM G 60 as a minimum. This certification requirement shall be satisfied by submitting by an approved independent laboratory to the certification agency.

2319.17.2.3 Fabrication.

2319.17.2.3.1 Manufacturers of prefabricated wood truss assemblies shall obtain a valid certificate of competency from the authority having jurisdiction.

2319.17.2.3.2 Each truss shall bear the fabricators stamp on a web member and 75 percent shall be placed so as to be clearly visible after erection and before placement of ceiling.

2319.17.2.3.3 Multiple member girder trusses shall be predrilled at the truss plant for connection bolts only. Hanger bolt holes shall be drilled on-site on location indicated on approved drawings.

2319.17.2.3.4 Each manufacturer or fabricator shall retain the services of applicable organizations among those listed below for monthly inspections of the lumber grade used in fabrication. Following each inspection, a report shall be submitted by the inspection agency to the authority having jurisdiction. All inspection agencies providing any type of inspection services shall be approved by the authority having jurisdiction.

For Pine: Southern Pine Inspection Bureau or Timber Products grading agencies with appropriate jurisdiction.

For Douglas Fir, Hem-Fir or Fir-Larch: Western Wood Products Association or West Coast Lumber Inspection Bureau. Timber Products Inspection Inc. or other grading agencies with appropriate jurisdiction.

2319.17.2.3.5 In addition, the fabricator shall employ an approved testing laboratory to conduct inspections of fabrication compliance. Such inspections shall be made unannounced and at random at least once a month. Following each inspection, a report on approved forms shall be submitted by the laboratory to the authority having jurisdiction and such reports shall bear the date, signature and seal of the supervising Florida-registered architect or professional engineer.

2319.17.2.3.6 When there is evidence of noncompliance with the provisions for fabrication set forth in this paragraph or with the approved plans, the authority having jurisdiction may require the inspection laboratory to make additional job-site or plant inspections.

2319.17.2.3.7 The authority having jurisdiction may require load testing on noncomplying wood trusses. The test results shall be reported to the authority having jurisdiction.

2319.17.2.3.8 Failure of units tested or receipt of inspection reports indicating fabrication not in accordance with approved truss design drawings, or failure to submit required inspection and/or test reports, shall be cause for suspension or revocation of the certificate of competency of the manufacturer or fabricator.

2319.17.2.4 Truss erection.

2319.17.2.4.1 All trusses shall be erected in accordance with TPI/WTCA BCSI 1 in addition to any requirements indicated on the approved permit document.

2319.17.2.4.2 For trusses having an overall length of the bottom chord in excess of 35 feet (10.7 m) or 6 feet (1829 mm) overall height erection shall be supervised by either a registered professional engineer or registered architect retained by the contractor. A retainer letter from the registered professional engineer or registered architect shall be submitted along with the shop drawings as part of the permit document.

2319.17.2.4.3 Temporary bracing shall be required during the erection of roof trusses to keep the trusses in a true plumb position and to prevent toppling of the trusses during erection, until the roof sheathing is applied. The provisions for temporary bracing shown in TPI/WTCA BCSI 1 shall be used for this bracing or a professional engineer or architect shall design the temporary bracing system. The ultimate responsibility to see this bracing is installed properly during the erection process lies with the permit holder. This bracing is extremely important for the protection of life and property during the erection process. Temporary truss bracing shall always be required.

2319.17.2.4.4 At gable ends, this diaphragm shall be designed to transmit lateral loads imposed on the gable to roof diaphragms and/or ceiling diaphragms where available. Where the wall supporting the gable is not designed to withstand lateral loads independent of the gable (by using shear walls or other methods), anchorage of the gable to the wall shall be designed to transmit the loads from the wall to the bracing and the bracing designed to transmit the lateral loads from the gable and wall to the roof diaphragms and/or ceiling diaphragms where available. Ceiling diaphragms that provide lateral support at gable walls shall be designed by the architect or professional engineer of record, and shall have continuous bottom chord bracing, end restraints, intermediate restraints and conditions so as to sufficiently transfer the lateral loads at the top of the gable end walls to the intersecting shear walls. In no case shall the rigid ceiling as defined in Section 2319.17.1.2 be used as an integral part of the system needed for lateral bracing of the gable end walls.

2319.17.2.4.5 Where masonry or reinforced concrete extends above wood trusses; trusses shall be designed so as not to compromise the structural integrity of the masonry or concrete wall it abuts in the event of collapse caused by fire.

SECTION 2320 HIGH-VELOCITY HURRICANE ZONES — FIRESTOPS

2320.1 Firestopping shall be provided to cut off all concealed draft spaces both vertical and horizontal.

2320.1.1 Firestops shall form effective fire barriers between stories and between a story and roof space.

2320.1.2 Firestopping shall be tightly and securely fitted into place and where of wood, shall be not less than a nominal 2 inches (51 mm) in thickness.

2320.1.3 Spaces between chimneys and wood framing shall be solidly filled with mortar or loose incombustible materials supported on incombustible supports.

2320.1.4 Firestopping shall consist of 2-inch (51mm) nominal lumber, or two thicknesses of 1 inch (25 mm) nominal lumber with broken lap joints, or 1 thickness of $^{23}/_{32}$ inch (18 mm) plywood, with joints backed by $^{23}/_{32}$ inch (18 mm) plywood, or other approved materials.

2320.1.5 Draftstopping materials shall be not less than $^{3}/_{8}$ inch (9.5 mm) plywood or other approved materials adequately supported.

2320.1.6 Required firestops and draftstops shall be continuous, and such continuity shall be maintained throughout. Penetrations of firestops or draft stops shall be sealed or proected in an approved manner.

2320.1.7 Ventilation of concealed roof spaces shall be maintained in accordance with Section 2326.3.2.

2320.2 Firestopping shall be installed in wood frame construction in the locations specified in Sections 2320.2.1 through 2320.2.6.

2320.2.1 In concealed spaces of stud walls and partitions including furred spaces at ceiling and floor levels to limit the maximum dimension of any concealed space to 8 feet (2438 mm).

2320.2.2 At all interconnections between concealed vertical and horizontal spaces such as occur at soffits, drop ceilings, cove ceilings and similar features.

2320.2.3 In concealed spaces between stair stringers at least once in the middle of each run, at the top and bottom, and between studs along and in line with adjacent run of stairs of the run.

2320.2.4 At openings around vents, pipes, ducts, chimneys and fireplaces at ceiling and floor levels with approved noncombustible materials, except in the case of approved metal chimney installation.

2320.2.5 In concealed spaces created by an assembly of floor joists, firestopping shall be provided for the full depth of the joists at the ends and over the support.

2320.2.6 Around the top, bottom and sides of door pockets.

2320.3 Draftstopping. Draftstopping shall be provided in wood frame construction in the locations specified in Sections 2320.3.1 and 2320.3.2.

2320.3.1 Floor-ceiling assemblies.

2320.3.1.1 Group B and M occupancies. In the floor-ceiling assemblies above and in line with the tenant separation, when tenant separation walls do not extend to the floor sheathing above.

2320.3.1.2 Groups R1, R2 and R4 occupancies. In floor-ceiling assemblies separating usable spaces into two or more approximate areas with no area greater than 500 square feet (46.5 m^2). Draftstopping shall be provided parallel to the main framing members in the floor-ceiling assemblies of multiple-family dwellings, motels and hotels above and in line with the tenant separation, when tenant separation walls do not extend to the floor sheathing above.

2320.3.1.3 Other occupancies. All other buildings, in floor-ceiling assemblies so that horizontal areas do not exceed 1,000 square feet (93 m^2).

2320.3.2 Attics.

2320.3.2.1 Group R1. In the floor-ceiling assemblies above and in line with the tenant separation, when tenant separation walls do not extend to the floor sheathing above.

2320.3.2.2 Group R3. None required.

Exceptions:

1. Where corridor walls provide a tenant separation, draftstopping shall be required above only one of the corridor walls.
2. Where flat roofs with solid joist construction are used, draftstopping over tenant separation walls is not required.
3. Where approved sprinklers are provided, draftstopping shall be required for attic spaces over 9000 square feet (836 m^2) in area.

2320.3.2.3 Other buildings. In attic spaces so that horizontal areas do not exceed 3,000 square feet (279 m^2).

Exceptions:

1. Where flat roofs with solid joist construction are used, draftstopping over tenant separation walls is not required.
2. Where approved sprinklers are provided, the area may be tripled.

SECTION 2321 HIGH-VELOCITY HURRICANE ZONES — ANCHORAGE

2321.1 Anchorage shall be continuous from the foundation to the roof and shall satisfy the uplift requirements of Section 1620.

2321.2 Joists.

2321.2.1 Fire-cuts into a masonry wall shall be anchored to the concrete beam on which they bear.

2321.2.2 Such anchors shall be spaced not more than 4 feet (1219 mm) apart and shall be placed at opposite ends across the building on the same run of joists.

2321.3 Joists shall be nailed to bearing plates, where such plates occur, to each other where continuous at a lap and to the studs where such studs are contiguous; and ceiling joists shall be nailed to roof rafters where contiguous.

2321.4 Every roof rafter and/or roof joist shall be anchored to the beam or studs on which they bear, and roof rafters opposing at a ridge shall be anchored across the ridge as set forth in Section 2321.6.

2321.5 Anchorage to concrete.

2321.5.1 Anchorage designed to resist uplift forces, securing wood to concrete shall be steel straps embedded in the concrete minimum of 4 inches (102 mm) with hooking devices to top steel of tie beam designed to withstand the uplift forces set forth by the design professional. Straps shall be approved under the criteria set by the certification agency. All anchors and related fasteners shall be galvanized.

2321.5.2 As an alternate to using the straps described in this section, the building official may approve other anchorage submitted by a Florida-registered professional engineer or a Florida-registered architect, proficient in structural design, provided that the information set forth in Section 2321.7(1), (2) and (3) submitted in connection with such anchors and such anchors and the proposed assembly otherwise comply with the requirements of this code.

2321.6 Anchorage to wood.

2321.6.1 Anchorage designed to resist uplift forces, securing wood to wood shall be steel straps nailed to each member and shall be designed to resist uplift forces set forth by the design professional. Straps shall be approved under the criteria set by the certification agency. All anchors and relative nails shall be galvanized.

2321.6.2 As an alternate to using straps described in this section, the building official may approve other anchorage submitted by a Florida-registered architect or a Florida registered professional engineer, proficient in structural design, provided that the information set forth in Section 2321.7(1), (2) and (3) submitted in connection with such anchors and such anchors and the proposed assembly otherwise comply with the requirements of this code.

2321.7 Testing of anchoring. Anchoring required by Sections 2321.5 and 2321.6 shall be tested under the following criteria:

1. Concrete to wood straps: Minimum design uplift load 700 pounds (3114 N), with four 16d nails with upper end bent over truss chord and nailed. Nails shall be clinched. Anchors shall have devices to hook into upper tie beam steel and embedded a minimum of 4 inch (102 mm) in concrete.
2. Wood to wood straps: Minimum design uplift 700 pounds (3114 N) with 4 16d nails in each member.
3. Other anchors: Minimum design uplift 700 pounds (3114 N).
4. The criteria stated in Section 2321.7(1), (2) and (3) above are minimum requirements for product approval for the certification agency. Anchor design and uplift forces shall be submitted to the certification agency for approval together with sufficient documentation and test data to verify performance. A product approval shall be maintained at the job site for the inspector to compare with the uplift force requirements of the design professional as shown on approved plans.

SECTION 2322
HIGH-VELOCITY HURRICANE ZONES — SHEATHING

2322.1 Floor sheathing.

2322.1.1 Floor sheathing, where a part of a required fire-resistive assembly, shall comply with a nationally recognized testing agency (Underwriter's Laboratory, Factory Mutual, etc.).

2322.1.2 The finish floor shall be tongue-and-grooved not less than nominal 1-inch (25 mm) lumber laid perpendicular to the joists with end joints on the joists, or a subfloor shall be provided as set forth in Sections 2322.1.3, 2322.1.4, 2322.1.5, and 2322.1.6.

2322.1.3 Square-edged or spaced subflooring may be used only under a finish floor having a strength equal to or greater than $^1/_2$ inch (12.7 mm) tongue-and-groove wood strip flooring; and under finish floors of less strength, a tongue-and-groove or plywood subfloor shall be required.

2322.1.4 Lumber subflooring shall be not less than $^5/_8$-inch (17 mm) thick when joists are spaced no more than 16 inches (406 mm) on center nor less than $^3/_4$ inch (19 mm) thick when joists are spaced no more than 24 inches (610 mm) on center. End joints shall be on joists, joints shall be staggered and parallel to the joists, and ends at walls and similar places shall be supported by a ribbon or by blocking.

2322.1.5 Plywood subfloors of C-D grade or underlayment grade bonded to wood joist using adhesives meeting the requirements of ASTM D 3498 shall be applied as indicated in Section 2322.1.6.

2322.1.6 Plywood subflooring shall be continuous over two or more spans with face grain perpendicular to the supports. The allowable spans shall not exceed those set forth in Table 2322.1.6.

TABLE 2322.1.6
PLYWOOD SUBFLOOR[1]

PANEL SPAN RATING[2]	MAXIMUM PLYWOOD SPAN (IN.)[3]
32/16	16[4]
40/20	20[4]
48/24	24

For SI: 1 inch = 25.4 mm.
NOTES:
1. These values apply for Sheathing C-D and C-C grades only. Spans shall be limited to values shown, and reduced for the possible effects of concentrated loads.
2. Span Ratings shall appear on all panels.
3. Plywood edges shall have approved tongue-and-groove joints or shall be supported with blocking unless $^1/_4$ inch minimum thickness underlay is installed or $^1/_2$ inch of approved cellular or lightweight concrete is installed or unless finish floor is 1inch nominal wood strip. Allowable uniform load based on deflection of 1/360 of span is 100 pounds per square foot.
4. May be 24 inches if nominal 1 inch wood strip finish floor is laid at right angles to joists.

2322.1.6.1 Plywood panels shall be nailed to supports with 6d common nails when up to $^1/_2$-inch thick (13 mm) , 8d common nails when $^{19}/_{32}$ to $^3/_4$ inch (15 to 19 mm) thick and 10d common nails or 8d ring shank when 1 $^1/_8$ inches (29 mm) thick.

2322.1.6.2 Nail spacing shall be 6 inches (152 mm) o.c. at panel edges and 10 inches (254 mm) o.c. at intermediate supports.

2322.1.7 Any other subfloor panel shall have certification agency approval and shall be installed in accordance with the procedures set forth in the approval.

2322.1.8 Flooring shall be nailed with 8d common nails up to $^3/_4$ inch (19 mm) thick, and 10d common nails or 8d ring shank nails when greater than $^3/_4$ inch (19 mm) thick up to 1 $^1/_8$ inches (29 mm) thick.

2322.1.8.1 Nails shall be hand driven 8d common nails [0.131 inch (3.3 mm) diameter by 2 $^1/_2$ inches (63.5 mm) long with 0.281 inch (7.1 mm) diameter full round head)] or power driven 8d nails of the same dimensions (0.131 inch diameter by 2 $^1/_2$ inches long with 0.281 inch diameter full round head). Nails of a smaller diameter or length may be used only when approved by an architect or professional engineer and only when the spacing is reduced accordingly.

2322.1.8.2 Nails shall be hand driven 10d common nails [0.148 inch (3.8 mm) diameter by 3 inch (76 mm) long with 0.312 inch (7.9 mm) diameter full round head] or power driven 10d nails of the same dimensions [0.148 inch (3.8m) diameter by 3 inch (76 mm) long with 0.312 inch (7.9 mm) diameter full round head]. Nails of a smaller diameter or length may be used only when approved by an architect or professional engineer and only when the spacing is reduced accordingly.

2322.1.9 Nail spacing shall be 6 inches (152 mm) on center at panel edges and 10 inches (254 mm) on center at intermediate supports.

2322.1.10 Flooring shall be nailed with 8d common nails not less than two in each board at each support.

2322.1.11 Floors for heavy timber buildings shall be sheathed as specified for mill floors, Section 2319.13.

2322.1.12 Flooring shall not extend closer than $^1/_2$ inch (13 mm) from masonry walls.

2322.1.13 If resilient flooring is to be applied directly to a plywood subfloor without separate underlayment, the plywood shall have a top ply of C-plugged grade or better, and the ply immediately under the face shall be at least C grade unless the face ply is $^1/_6$ inch (4.2 mm) or more in nominal thickness. Plywood shall be continuous over two or more spans with face grain perpendicular to supports. Maximum thickness and maximum joist spacing shall comply with Table 2322.1.13.

TABLE 2322.1.13
ALLOWABLE SPAN FOR PLYWOOD COMBINATION SUBFLOOR UNDERLAYMENT[1]
(SINGLE FLOOR PANELS)

SPECIES GROUPS	MAXIMUM PLYWOOD SPAN (IN.)[2, 3]			
	16[4]	5/8[4]	24	48
1	1/2"	5/8"	3/4"	
2,3	5/8"	3/4"	7/8"	
4	3/4"	7/8"	1"	
1, 2 and 3				1-1/8"

For SI: 1 inch = 25.4 mm.

NOTES:

1. Applicable underlayment grade, C-C (plugged) and all grades of sanded Exterior type plywood.
2. Spans shall be limited to values shown, and reduced for the possible effects of concentrated loads.
3. Allowable uniform load based on deflection of 1/360 of span is 100 pounds per square foot except that total load for 48" on center is 65 pounds per square foot. Plywood edges shall have approved tongue-and-groove joints or shall be supported with blocking unless 1/4 inch minimum thickness underlay is installed or 1/2 inch of approved cellular or lightweight concrete is placed over the subfloor and the sheathing is rated for Exposure 1.
4. If a wood finish floor is laid perpendicular to the joists or supports, thickness shown for 16 inch and 20 inch spans may be used for 24 inch spans.

2322.1.14 Underlayment hardboard shall meet the property requirements for $^{7}/_{32}$ inch (5.6 mm) and $^{1}/_{4}$ inch (6.4 mm) service hardboard and shall be 0.215 +/-0.005 inch (5.5 +/-0.13 mm) thickness; when supported in subflooring such subflooring shall comply with the requirements of Sections 2322.1.3, 2322.1.4, 2322.1.5, and 2322.1.6.

2322.1.15 Particleboard floor underlayment shall conform to Type 1-B-1 of the standard listed in Section 2314.4. Underlayment shall be not less than $^{1}/_{4}$ inch (6.4 mm) in thickness and shall be installed in accordance with the installation instructions of the National Particleboard Association.

2322.1.16 Diaphragm boundaries. All floor sheathing acting as a diaphragm shall be attached to a minimum 2-inch-thick (51 mm) nominal nailer with its depth equal to or one size greater than the intersecting top chord. The nailer shall be connected to the wall to resist the gravity loads from the floor, wind pressure/suction from the exterior wall and the diaphragm forces. The floor sheathing shall be attached to the nailer to resist the wind pressure/suction from the exterior wall and the diaphragm forces.

2322.2 Roof sheathing.

2322.2.1 Wood roof sheathing shall be boards or shall be plywood.

2322.2.2 Board roof sheathing shall have a net thickness of not less than $^{3}/_{4}$ inch (19 mm) when the span is not more than 28 inches (711 mm) or $^{5}/_{8}$ inch (17 mm) when the span is not more than 24 inches (610 mm), shall have staggered joints and shall be nailed with 8d common nails not less than two in each 6 inch board nor three in each 8-inch (203 mm) board at each support.

2322.2.3 Plywood roof sheathing shall be rated for Exposure 1, have a minimum nominal thickness of $^{19}/_{32}$ inch (15 mm) and shall be continuous over two or more spans with face grain perpendicular to supports. Roof sheathing panels shall be provided with a minimum of 2 inch by 4 inch (51 mm by 102 mm) edgewise blocking at all horizontal panel joints with edge spacing in accordance with manufacturer's specifications, for a distance at least 4 feet (1219 mm) from each gable end. The allowable spans shall not exceed those set forth in Table 2322.2.3.

2322.2.4 Plywood panels shall be nailed to supports with 8d ring shank nails.

2322.2.5 Nail spacing shall be 6 inches (152 mm) on center at panel edges and at intermediate supports. Nail spacing shall be 4 inches (102 mm) on center at gable ends with either 8d ring shank nails or 10d common nails.

2322.2.5.1 Nails shall be hand driven 8d ring shank or power driven 8d ring shank nails of the following minimum dimensions: (a) 0.113 inch (2.9 mm) nominal shank diameter, (b) ring diameter of 0.012 inch (0.3 mm) over shank diameter, (c) 16 to 20 rings per inch, (d) 0.280 inch (7.1 mm) full round head diameter, (e) 2- inch (60.3 mm) nail length. Nails of a smaller diameter or length may be used only when approved by an architect or professional engineer and only when the spacing is reduced accordingly.

2322.2.5.2 Nails at gable ends shall be hand driven 8d ring shank or power driven 8d ring shank nails of the following minimum dimensions: (a) 0.113 inch (2.9 mm) nominal shank diameter, (b) ring diameter of 0.012 inch (0.3 mm) over shank diameter, (c) 16 to 20 rings per inch, (d) 0.280 inch (7.1 mm) full round head diameter, (e) 2 $^{3}/_{8}$ inch (60.3 mm) nail length or as an alternative hand driven 10d common nails [0.148 inch (4 mm) diameter by 3 inches (76 mm) long with 0.312 inch (7.9 mm) diameter full round head] or power driven 10d nails of the same dimensions [0.148 inch (4 mm) diameter by 3 inches (76 mm) long with 0.312-inch-diameter (8 mm) full round head]. Nails of a smaller diameter or length may be used only when approved by an architect or professional engineer and only when the spacing is reduced accordingly. Other products with unique fastening methods may be substituted for these nailing requirements as approved by the building official and verified by testing.

2322.2.5.3 Other products with unique fastening methods may be substituted for these nailing requirements as approved by the building official and verified by testing.

TABLE 2322.2.3
ALLOWABLE SPAN FOR PLYWOOD ROOF SHEATHING[1]

PANEL SPAN RATING[2]	MAXIMUM SPAN IF BLOCK OR OTHER EDGE SUPPORTS (IN.)	MAXIMUM SPAN WITHOUT EDGE SUPPORT (IN.)
32/16	24	24
40/20	40	32
48/24	48	36

For SI: 1 inch = 25.4 mm.
NOTES:
1. Values apply to sheathing grade, C-C and C-D panels.
2. Span Rating appears on all C-C and C-D panels.

2322.2.6 Roof sheathing for heavy timber construction shall comply with Section 2319.13 of this code.

2322.2.7 Diaphragm boundaries. All roof sheathing acting as a diaphragm shall be attached to a minimum 2-inch (51 mm) thick nominal member with its depth equal to or one size greater than the intersecting top chord. This shall be achieved with a continuous structural subfascia, fascia or blocking at 4 inches (102 mm) on center with nails as required for the appropriate thickness of sheathing.

2322.2.8 When existing roofs are reroofed to the point that the existing roofing is removed down to the sheathing, the existing roof sheathing shall be renailed with 8d common nails [0.131 inch (3.3 mm) diameter by 2 $^1/_2$ inches (63.5 mm) long with 0.281 inch (7.9 mm) diameter full round head]. Nail spacing shall be 6 inches (152 mm) on center at panel edges, 6 inches (152 mm) on center at intermediate supports and where applicable 4 inches (102 mm) on center over gable ends and subfascia. Existing fasteners may be used to achieve such minimum spacing.

2322.3 Storm sheathing. Exterior stud walls shall be sheathed to resist the racking load of wind as set forth in Section 1620 and the concentrated loads that result from hurricane-generated wind-borne debris as set forth in Section 1626 of this code and shall be at a minimum any of the following types:

1. Tightly fitted, diagonally placed boards not less than $^5/_8$ inch (17 mm) thickness, nailed with three 8d common nails to each support for 1 inch by 6 inch (25 mm by 152 mm) boards and four 8d common nails for 1 inch by 8 inches (25 mm by 203 mm) boards.
2. Wall sheathing shall be plywood, or Product Approved structural panel, rated Exposure 1 with a minimum thickness of $^{19}/_{32}$ inch (15 mm) and shall be applied to studs spaced not more than 16 inches (406 mm) on center. Wall sheathing shall be continuous over three or more supports and shall be nailed to such supports with 8d common nails. Nail spacing shall not exceed 6 inches (152 mm) on center at panel edges and all intermediate supports. Nail spacing shall be 4 inches (102 mm) on center at corner studs, in all cases.
3. When plywood panel, or Product Approved structural panel, sheathing is used, building paper and diagonal wall bracing can be omitted.
4. When siding such as shingles nailed only to plywood or Product Approved structural panel sheathing, the panel shall be applied with face grain across studs.

2322.4 Exterior wall cladding.

2322.4.1 Plywood, if protected with stucco, may serve for both sheathing and exterior cladding provided:

1. The panel thickness shall be not less than $^{19}/_{32}$ inch (15 mm) and Texture 1-11 panels, and the supporting studs shall be spaced not more than 16 inches (406 mm) o.c.
2. All joints shall be backed solidly with 2 inch (51 mm) nominal blocking or studs or the joints shall be lapped horizontally or otherwise watertight.
3. Nailing shall be as set forth in Section 2322.3(2).

2322.4.2 Where storm sheathing is provided in accordance with Section 2322.3, exterior cladding may be one of the following:

1. Wood siding shall be installed according to its Product Approval.
2. Wood shingles or shakes attached to the storm sheathing, and/or to nailing boards or shingle backer securely attached to the storm sheathing. The minimum thickness of wood shingles or shakes between nailing boards shall be $^3/_8$ inch (9.5 mm).
3. Hardboard of siding quality for exterior use shall be applied in accordance with the Product Approval.

SECTION 2323
HIGH-VELOCITY HURRICANE ZONES—FURRING

2323.1 Where the interior of masonry walls is furred, such furring shall be treated and firestopped as herein required and shall be securely fastened to the masonry with not less than one cut nail in alternate course of block.

SECTION 2324
HIGH-VELOCITY HURRICANE ZONES—CONNECTORS

2324.1 The allowable loads on all types of connectors shall be as set forth in the standards listed in Section 2314.4 and Table 2324.1.

2324.2 Nails, bolts and other metal connectors that are used in locations exposed to the weather shall be galvanized or otherwise corrosion resistant.

2324.3 In general, nails shall penetrate the second member a distance equal to the thickness of the member being nailed thereto. There shall be not less than two nails in any connection.

2324.4 Except for wood-based structural-use panels and other laminated members manufactured under technical control and rigid inspection, gluing shall not be considered an acceptable connector in lieu of the connectors herein specified.

2324.5 Safe loads and design practice for types of connectors not mentioned or fully covered herein shall be determined by the building official before approval.

SECTION 2325
HIGH-VELOCITY HURRICANE ZONES–WOOD SUPPORTING MASONRY

2325.1 Wood shall not support masonry or concrete except as permitted in Sections 2325.2 and 2325.3.

2325.2 Wood foundation piles may be used to support concrete or masonry.

2325.3 Plywood decking and approved wood panels, wood joists and wood studs supporting such wood joists may be used to support reinforced concrete slabs, concrete-base tile and terrazzo floors and lightweight concrete toppings as follows:

1. There shall be an approved moisture vapor barrier between the concrete or other cementitious materials and the wood.
2. Wood members supporting concrete shall be preservative treated in compliance with the standards of AWPA and AWPB set forth in Sections 2314.4 and 2326.
3. Approved wood-based structural-use panel decking shall be rated for Exposure 1.
4. Wood rafters may support concrete roof tile.

SECTION 2326
HIGH-VELOCITY HURRICANE ZONES — PROTECTION OF WOOD

2326.1 Wood piles shall be treated with preservatives as set forth in Section 1823.1.2.

2326.2 Preservative treated or durable species wood.

2326.2.1 All wood used in areas of building or structures where the climatic condition is conducive to deterioration which would affect the structural safety shall be treated in an approved method with an approved preservative or shall be of an approved durable species.

2326.2.2 All wood in contact with or embedded in the ground that supports of permanent structures shall be approved pressure-treated wood suitable for ground contact use.

Exceptions:

1. Naturally durable wood or pressure-treated wood may be used in contact with the ground for support of structures other than buildings and walking surfaces.
2. Untreated wood may be used for supports where entirely below water level and continuously submerged in fresh water.

2326.2.3 Sleepers and sills on concrete slabs in contact with the ground, wood joists and the underside of wood structural floors without joists less than 18 inches (457 mm) above ground; or wood girders less than 12 inches (305 mm) from exposed ground within the crawl space under buildings, shall be treated in an approved method with an approved preservative, or shall be of an approved durable species.

TABLE 2324.1
NAIL CONNECTION FOR WOOD MEMBERS

CONNECTION	COMMON NAILS	NUMBER OR SPACING
Joists to sill or girder, toe nail	16d	2
Bridging to joist, toe nail	8d	2 each end
1-inch x 6-inch subfloor or less to each joist, face nail	8d	2
Over 1-inch x 6-inch subfloor to each joist, face nail	8d	3 + 1 for each size increase
2-inches subfloor to joist or girder, blind and face nail	16d	2
Sole plate to joist or blocking, face nail	16d	16 inches o.c.
Top or sole plate to stud, end nailed	16d	2
Stud to sole plate, toe nail	3d	3 or 2 16d
Doubled studs, face nail	16d	24 inches o.c.
Doubled top plates, face nail	16d	16 inches o.c.
Top plates, laps and intersections, face nail	16d	2
Continuous header, two pieces	16	16 inches o.c.along each edge
Ceiling joists to plate, toe nail	16d	2
Continuous header to stud, toe nail	16d	3
Ceiling joists, laps over partitions, face nail	16d	3
Ceiling joists to parallel rafters, face nail	16d	3
Rafter plate, toe nail	16d	3
1-inch x 6-inch sheathing or less, to each bearing, face nail	8d	2
Over 1-inch x 6-inch sheathing, to each bearing, face nail	8d	3 + 1 for each size increase
Built-up corner studs, face nail	16d	30 inches o.c.
Built-up girders and beams	20d	32 inches o.c. At top and bottom and staggered, 2 at ends and at each splice
2-inch planks	16d	2 each bearing

For SI: 1 inch = 25.4 mm.
NOTE: In spacing specifications, o.c. means “on-center.”

2326.2.4 All wood not separated from and/or in direct contact with concrete masonry, including sills, sleepers, plates, posts, columns, beams, girders and furring; shall be treated in an approved method with and approved preservative, or shall be of an approved durable species.

2326.2.5 The expression "pressure treated wood" refers to wood meeting the retention, penetration and other requirements applicable to the species, product, treatment and conditions of use in the approved standards of the American Wood Preservers Association (AWPA). Quality Control Program for Softwood Lumber, Timber and Plywood Pressure Treated with Water-borne Preservatives for Ground Contact Use in Residential and Light Commercial Foundations for the American Wood Preservers Bureau.

2326.2.6 The expression "durable wood" refers to the heartwood of the following species with the exception that an occasional piece with corner sapwood may be included if 90 percent or more of the width of each side on which it occurs is heartwood:

Decay resistant: Redwood, Cedars, Black Locust.

Termite resistant: Redwood, Bald and Eastern Red Cedar.

2326.2.7 Where durable species of wood are used as structural members in buildings and structures, the stress grade shall be not less than that required in Section 2317.

2326.2.8 When wood pressure treated with a waterborne preservative is used in enclosed locations where drying in service cannot readily occur, such wood shall have a moisture content of 19 percent or less before being covered with insulation, interior wall finish, floor covering or other material.

2326.2.9 All wood framing less than 8 inches (203 mm) from exposed earth in exterior walls that rest on concrete or masonry foundations shall be approved naturally durable species or pressure treated wood.

2326.2.10 All posts, poles and columns embedded in concrete which is in contact with ground and supporting permanent structures shall be approved pressure treated wood suitable for ground contact use except naturally durable wood may be used for posts, poles and columns embedded in concrete for structures other than buildings and walking surfaces or in structures where wood is above ground level and not exposed to the weather.

2326.2.11 For conditions not specifically covered, compliance with American Forest & Paper Product Association Wood Construction Data #6 "Design of Wood Frame Structures for Permanence" shall be deemed as compliance with this code.

2326.3 Ventilation.

2326.3.1 Ventilation of crawl spaces. Crawl spaces under buildings without basements shall be ventilated by approved mechanical means or by openings in foundation walls. Ventilation openings shall be covered with a corrosion-resistant wire mesh with openings not greater than $^1/_{16}$ inch (1.6 mm).

2326.3.1.1 Where practicable, ventilating openings shall be arranged on three sides.

2326.3.1.2 The minimum total area of ventilating openings shall be 2 square feet (0.19 m^2) for each 15 linear feet (4.6 m) or a fraction thereof of exterior wall. Such opening need not be placed in the front of the building. Where mechanical ventilation is used, the ventilation rate shall be at least six air changes per hour.

2326.3.2 Ventilation of attic spaces. Attic space between ceiling joists and roof rafters shall be effectively cross-ventilated by approved mechanical means or with vent openings. The ratio of total net free ventilating area to the area of the ceiling shall be not less than $^1/_{150}$.

Exception: The venting ratio may be reduced to $^1/_{300}$ where at least 50 percent of the installed ventilating area is provided by a ventilation system located in the upper portion of the space to be ventilated [within 18 inches (457 mm) of ridge]. The balance of the required ventilation shall be provided by eave or cornice vents.

2326.3.2.1 Where practical, ventilating openings shall be arranged on three sides.

2326.3.2.2 Where mechanical ventilation is used, the ventilation rate shall be at least six air changes per hour.

2326.3.2.3 All openings into the attic space of any habitable building shall be covered with screening, hardware cloth or equivalent to prevent the entry of birds, squirrels, rodents, etc. The openings therein shall not exceed $^1/_8$ inch (3.2 mm).

2326.3.2.4 For existing structures that were built before 1992 without soffit ventilation, and where in the opinion of the building official the soffit ventilation would be impossible or impractical to install, the building official may determine the extent to which the existing structure shall be made to conform to the requirements of this section.

2326.4 Debris.

2326.4.1 Before any new building is erected, all stumps and roots shall be removed from the soil to a depth of at least 12 inches (305 mm) below the surface of the ground in the area to be occupied by the building.

2326.4.2 In buildings or portions thereof having wood first-floor systems, all wood forms which have been used in placing concrete, if within the ground or less than 18 inches (457 mm) above the ground, shall be removed before the building is occupied or used for any purpose.

2326.4.3 Loose or casual wood shall not be stored in direct contact with the ground under any building, and this space must be thoroughly cleaned of all wood and debris.

2326.5 Termite protection. All buildings shall have a pre-construction treatment protection against subterranean termites. The rules and laws as established by the Florida Department of Agriculture and Consumer Services shall be deemed as approved with respect to pre-construction soil treatment for protection against subterranean termites. A certificate of compliance shall be issued to the building department by the licensed pest control company that contains the following statement: "The building has received a complete treatment for the prevention of subterranean termites. Treatment is in accordance with rules and laws established by the Florida Department of Agriculture and Consumer Services."

2326.6 Existing buildings. Whenever the building official has knowledge of the existence of termites in any building or structure, he shall notify the owner in writing and direct that necessary measures be taken for the extermination of the termites within a reasonable length of time, not to exceed 60 days.

2326.6.1 The building official shall inspect existing buildings having wood-stud exterior walls for which application for a permit for exterior wall coverings is made and shall have the authority to order the uncovering of structural elements for inspection and to require necessary repairs as a part of such approval for a permit, or may order demolition.

SECTION 2327 HIGH-VELOCITY HURRICANE ZONES—FIRE RETARDANT WOOD

2327.1 Fire-retardant-treated wood shall be defined as any wood product which, when impregnated with chemicals by a pressure process, or other means during manufacture, shall have when tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, a flame spread index of 25 or less and show no evidence of significant progressive combustion when the test is continued for an additional 20-minute period. In addition, the flame front shall not progress more than 10 feet (3 m) beyond the centerline of the burner at any time during the test.

2327.2 The allowable unit stresses for fire-retardant-treated wood including fastener values, shall be developed from an approved method which considers the effects of anticipated temperatures and humidity to which the fire-retardant wood will be subjected, the type of treatment and the redrying process.

2327.3 All fire-retardant-treated wood shall bear an identification mark showing the flame spread classification thereof issued by an approved agency having a reexamination service which maintains a continued supervision and inspection over method of drying. If intended for exterior use, the wood shall be further identified to indicate suitability for exposure to the weather, as defined in Section 2327.5.

2327.4 Where fire-retardant-treated wood is exposed to the weather, it shall be further identified to indicate that there is no increase in the listed flamespread classification as defined in Section 2322.1 when subjected to ASTM D 2898, *Standard Method for Accelerated Weathering of Fire Retardant Treated Wood for Fire Testing.*

2327.5 Where experience has demonstrated a specific need for use of material of low hygroscopicity, fire-retardant-treated wood to be subjected to high humidity conditions shall be identified as Type A to indicate the treated wood has a moisture content of not over 28 percent when tested in accordance with ASTM D 3201 procedures at 92-percent relative humidity.

2327.6 Fire-retardant-treated wood shall be dried to a moisture content of 19 percent or less for lumber and 15 percent or less for plywood before use. The identification mark shall show the method of drying after treatment. When fire-retardant-treated wood is air dried after treatment (ADAT) it shall be protected so that no leaching of chemicals will occur. Fire-retardant-treated wood kiln dried after treatment (KDAT) shall not be exposed to a dry bulb temperature exceeding 160ºF (71ºC). If required for curing, exterior fire-retardant-treated wood can be exposed to elevated temperatures when the moisture content of the wood does not exceed 19 percent for lumber or 15 percent for wood structural panels. The curing time shall not exceed 48 hours and the temperature shall not exceed 210ºF (99ºC).

SECTION 2328 HIGH-VELOCITY HURRICANE ZONE—WOOD FENCES

2328.1 Wood fences, so located on a property that by zoning regulations they cannot be used as a wall of a building, shall be constructed to meet the minimum specifications in Sections 2328.2 and 2328.3.

2328.2 Fences not exceeding 6 feet (1829 mm) in height, shall be constructed to meet the following minimum requirements: from nominal 4-inch by 4-inch by 8-feet-long (102 mm by 102 mm by 2438 mm) posts No. 2 grade or better spaced 4 feet (1219 mm) on center, and embedded 2 feet (610 mm) into a concrete footing 10 inches (254 mm) in diameter and 2 feet (610 mm) deep.

2328.3 Fences not exceeding 5 feet (1524 mm) or 4 feet (1219 mm) in height shall be constructed as provided in Section 2328.2, except that the spacing of posts may be increased to 5 feet (1524 mm) and 6 feet (1829 mm) on center for these heights, respectively.

SECTION 2329 HIGH-VELOCITY HURRICANE ZONES—FIRE-RETARDANT-TREATED SHAKES AND SHINGLES

2329.1 Treated shakes and shingles, when impregnated with chemicals by the full-cell vacuum pressure process, shall be considered fire retardant (classified) roof coverings when tested in accordance with ASTM E 108, *Fire Tests of Roof Coverings,* Including the rain test, ASTM D 2898, *Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing*. The fire-resistance tests shall include the intermittent flame test, spread of flame test, burning brand test and flying brand test. In addition, at the conclusion of the rain test, test panels shall be subjected to intermittent flame test, burning brand test and flying brand test.

2329.2 Each bundle of fire-retardant-treated shakes and shingles shall be identified with labels indicating the manufacturer, the classification of the material (Class B) and the quality control agency.

SECTION 2330
HIGH-VELOCITY HURRICANE ZONES—WOOD BLOCKING

2330.1 General.

2330.1.1 Blocking is defined as wood pieces attached to the roof deck or to each other for the purpose of securing roof membrane or accessories.

2330.1.2 Wood blocking attachment for buildings greater than 40 feet (12.2 m) in height must be designed by a registered architect or professional engineer.

2330.1.3 Wood blocking attachment for lightweight insulating concrete, gypsum concrete, cementitious wood fiber and cellular concrete decks shall be designed by a registered architect or professional engineer. The decks themselves shall not be used as a wood blocking attachment substrate.

2330.1.4 Wood blocking shall not be less than nominal 2 inches by 6 inches (51 mm by mm). The maximum unsupported overhang shall be 2 inches (51 mm). When the maximum overhang is employed, a nominal 2-inch by 6-inch (51 mm by mm) blocking shall be installed.

2330.1.5 In recover applications, wood blocking may be reduced to nominal 1 inch (25 mm), providing the attachment is secured in compliance with this code.

2330.1.6 Sound wood blocking may be reused in a recover or reroof application, providing the attachment is secured in compliance with the requirements of this code.

2330.1.7 A fastener shall be placed within 3 inches (761 mm) of the end of each section of wood blocking and a $^1/_4$-inch (6 mm) gap shall be left between each section of wood blocking. No piece of wood shall have less than two fasteners.

2330.1.8 Fasteners other than nails shall be predrilled prior to attachment and countersunk to be flush with the surface of the wood blocking.

2330.1.9 Wood shall be protected according to Section 2326.

2330.1.10 Powder actuated fasteners shall not be used in wood blocking attachment.

2330.2 Attachment to masonry block and concrete.

2330.2.1 Prior to the installation of wood blocking to standard weight masonry block, the two top courses shall be solidly filled with concrete or a tie beam shall be provided as required by this code.

2330.2.2 The fastener's average withdrawal resistance per lineal foot shall be not less than 250 pounds per foot (3649 N/m) after the application of a 4:1 safety factor.

2330.2.3 The pullover value of the proposed fastener though the wood blocking shall be not less than 125 percent of the design load of the proposed fastener. If less, a larger bearing washer shall be added to the fastener assembly to meet this requirement. Wood blocking thickness shall be not less than 1 $^1/_2$ inch (38 mm) if a bearing washer is required.

CHAPTER 24
GLASS AND GLAZING

SECTION 2401 GENERAL

2401.1 Scope. The provisions of this chapter shall govern the materials, design, construction and quality of glass, light-transmitting ceramic and light-transmitting plastic panels for exterior and interior use in both vertical and sloped applications in buildings and structures.

Exception: Buildings and structures located within the high-velocity hurricane zone shall comply with the provisions of Sections 2410 through 2415.

2401.2 Glazing replacement. The installation of replacement glass shall be as required for new installations.

SECTION 2402 DEFINITIONS

2402.1 Definitions. The following words and terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meanings shown herein.

DALLE GLASS. A decorative composite glazing material made of individual pieces of glass that are embedded in a cast matrix of concrete or epoxy.

DECORATIVE GLASS. A carved, leaded or Dalle glass or glazing material whose purpose is decorative or artistic, not functional; whose coloring, texture or other design qualities or components cannot be removed without destroying the glazing material and whose surface, or assembly into which it is incorporated, is divided into segments.

SECTION 2403 GENERAL REQUIREMENTS FOR GLASS

2403.1 Identification. Each pane shall bear the manufacturer's mark designating the type and thickness of the glass or glazing material. With the exception of tempered glazing materials or laminated materials, the identification shall not be omitted unless approved and an affidavit is furnished by the glazing contractor certifying that each light is glazed in accordance with approved construction documents that comply with the provisions of this chapter. Safety glazing shall be identified in accordance with Section 2406.2.

Each pane of tempered or laminated glass, except tempered spandrel glass, shall be permanently identified by the manufacturer. The identification mark shall be acid etched, sand blasted, ceramic fired, laser etched, embossed or of a type that, once applied, cannot be removed without being destroyed. Tempered or laminated spandrel glass shall be provided with a removable paper marking by the manufacturer.

2403.2 Glass supports. Where one or more sides of any pane of glass are not firmly supported, or are subjected to unusual load conditions, detailed construction documents, detailed shop drawings and analysis or test data assuring safe performance for the specific installation shall be prepared by a registered design professional.

2403.3 Framing. To be considered firmly supported, the framing members for each individual pane of glass shall be designed so the deflection of the edge of the glass perpendicular to the glass pane shall not exceed $^1/_{175}$ of the glass edge length or $^3/_4$ inch (19.1 mm), whichever is less, when subjected to the larger of the positive or negative load where loads are combined as specified in Section 1605.

2403.4 Interior glazed areas. Where interior glazing is installed adjacent to a walking surface, the differential deflection of two adjacent unsupported edges shall not be greater than the thickness of the panels when a force of 50 pounds per linear foot (plf) (730 N/m) is applied horizontally to one panel at any point up to 42 inches (1067 mm) above the walking surface.

2403.5 Louvered windows or jalousies. Float, wired and patterned glass in louvered windows and jalousies shall be no thinner than nominal $^3/_{16}$ inch (4.8 mm) and no longer than 48 inches (1219 mm). Exposed glass edges shall be smooth.

Wired glass with wire exposed on longitudinal edges shall not be used in louvered windows or jalousies.

Where other glass types are used, the design shall be submitted to the building official for approval.

SECTION 2404 WIND AND DEAD LOADS ON GLASS

2404.1 Vertical glass. Glass sloped 15 degrees (0.26 rad) or less from vertical in windows, curtain and window walls, doors and other exterior applications shall be designed to resist the wind loads for components and cladding. The load resistance of glass under uniform load shall be determined in accordance with ASTM E 1300. Design of exterior windows and glass doors in accordance with Section 2404.1 shall utilize the same edition of ASTM E 1300 used for testing in accordance with Section 1714.5.

The design of vertical glazing shall be based on the following equation:

$$F_{gw} \leq F_{ga} \qquad \textbf{(Equation 24-1)}$$

where:.

F_{gw} is the wind load on the glass computed in accordance with Section 1609 and F_{ga} is the short duration load resistance of the glass as determined in accordance with ASTM E 1300.

2404.2 Sloped glass. Glass sloped more than 15 degrees (0.26 rad) from vertical in skylights, sunrooms, sloped roofs and other exterior applications shall be designed to resist the most critical of the following combinations of loads.

$$F_g = W_o - D \qquad \textbf{(Equation 24-2)}$$

$F_g = W_i + D$ **(Equation 24-3)**

$F_g = 0.5\ W_i + D$ **(Equation 24-4)**

where:

D = Glass dead load psf (kN/m^2).

For glass sloped 30 degrees (0.52 rad) or less from horizontal,

= 13 t_g (For SI: 0.0245 t_g).

For glass sloped more than 30 degrees (0.52 rad) from horizontal,

= 13 t_g cos θ (For SI: 0.0245 t_g cos θ).

F_g = Total load, psf (kN/m^2) on glass.

t_g = Total glass thickness, inches (mm) of glass panes and plies.

W_i = Inward wind force, psf (kN/m^2) as calculated in Section 1609.

W_o = Outward wind force, psf (kN/m^2) as calculated in Section 1609.

θ = Angle of slope from horizontal.

Exception: Unit skylights shall be designed in accordance with Section 2405.5. The design of sloped glazing shall be based on the following equation:

$F_g \le F_{ga}$ **(Equation 24-5)**

F_g = Total load on the glass determined from the load combinations above.

F_{ga} = Short duration load resistance of the glass as determined according to ASTM E 1300 for Equations 24-2 and 24-3; or the long duration load resistance of the glass as determined according to ASTM E 1300 for Equation 24-4.

2404.3 Wired, patterned and sandblasted glass.

2404.3.1 Vertical wired glass. Wired glass sloped 15 degrees (0.26 rad) or less from vertical in windows, curtain and window walls, doors and other exterior applications shall be designed to resist the wind loads in Section 1609 for components and cladding according to the following equation:

$F_{gw} < 0.5\ F_{ge}$ **(Equation 24-6)**

where:

F_{gw} = Is the wind load on the glass computed per Section 1609.

F_{ge} = Nonfactored load from ASTM E 1300 using a thickness designation for monolithic glass that is not greater than the thickness of wired glass.

2404.3.2 Sloped wired glass. Wired glass sloped more than 15 degrees (0.26 rad) from vertical in skylights, sunspaces, sloped roofs and other exterior applications shall be designed to resist the most critical of the combinations of loads from Section 2404.2.

For Equations 24-2 and 24-3:

$F_g < 0.5\ F_{ge}$ **(Equation 24-7)**

For Equation 24-4:

$F_g < 0.3\ F_{ge}$ **(Equation 24-8)**

where:

F_g = Total load on the glass.

F_{ge} = Nonfactored load from ASTM E 1300.

2404.3.3 Vertical patterned glass. Patterned glass sloped 15 degrees (0.26 rad) or less from vertical in windows, curtain and window walls, doors and other exterior applications shall be designed to resist the wind loads in Section 1609 for components and cladding according to the following equation:

$F_{gw} < 1.0\ F_{ge}$ **(Equation 24-9)**

where:

F_{gw} = Wind load on the glass computed per Section 1609.

F_{ge} = Nonfactored load from ASTM E 1300. The value for patterned glass shall be based on the thinnest part of the glass. Interpolation between nonfactored load charts in ASTM E 1300 shall be permitted.

2404.3.4 Sloped patterned glass. Patterned glass sloped more than 15 degrees (0.26 rad) from vertical in skylights, sunspaces, sloped roofs and other exterior applications shall be designed to resist the most critical of the combinations of loads from Section 2404.2.

For Equations 24-2 and 24-3:

$F_g < 1.0\ F_{ge}$ **(Equation 24-10)**

For Equation 24-4:

$F_g < 0.6 F_{ge}$ **(Equation 24-11)**

where

F_g = Total load on the glass.

F_{ge} = Nonfactored load from ASTM E 1300. The value for patterned glass shall be based on the thinnest part of the glass. Interpolation between the nonfactored load charts in ASTM E 1300 shall be permitted.

2404.3.5 Vertical sandblasted glass. Sandblasted glass sloped 15 degrees (0.26 rad) or less from vertical in windows, curtain and window walls, doors, and other exterior applications shall be designed to resist the wind loads in Section 1609 for components and cladding according to the following equation:

$F_g < 0.5\ F_{ge}$ **(Equation 24-12)**

where:

F_g = Total load on the glass.

F_{ge} = Nonfactored load from ASTM E 1300. The value for sandblasted glass is for moderate levels of sandblasting.

2404.4 Other designs. For designs outside the scope of this section, an analysis or test data for the specific installation shall be prepared by a registered design professional.

SECTION 2405 SLOPED GLAZING AND SKYLIGHTS

2405.1 Scope. This section applies to the installation of glass and other transparent, translucent or opaque glazing material installed at a slope more than 15 degrees (0.26 rad) from the vertical plane, including glazing materials in skylights, roofs and sloped walls.

2405.2 Allowable glazing materials and limitations. Sloped glazing shall be any of the following materials, subject to the listed limitations.

1. For monolithic glazing systems, the glazing material of the single light or layer shall be laminated glass with a minimum 30-mil (0.76 mm) polyvinyl butyral (or equivalent) interlayer, wired glass, light-transmitting plastic materials meeting the requirements of Section 2607, heat-strengthened glass or fully tempered glass.
2. For multiple-layer glazing systems, each light or layer shall consist of any of the glazing materials specified in Item 1 above.

Annealed glass is permitted to be used as specified within Exceptions 2 and 3 of Section 2405.3.

For additional requirements for plastic skylights, see Section 2610. Glass-block construction shall conform to the requirements of Section 2101.2.5.

2405.3 Screening. Where used in monolithic glazing systems, heat-strengthened glass and fully tempered glass shall have screens installed below the glazing material. The screens and their fastenings shall: (1) be capable of supporting twice the weight of the glazing; (2) be firmly and substantially fastened to the framing members and (3) be installed within 4 inches (102 mm) of the glass. The screens shall be constructed of a noncombustible material not thinner than No. 12 B&S gage (0.0808 inch) with mesh not larger than 1 inch by 1 inch (25 mm by 25 mm). In a corrosive atmosphere, structurally equivalent noncorrosive screen materials shall be used. Heat-strengthened glass, fully tempered glass and wired glass, when used in multiple-layer glazing systems as the bottom glass layer over the walking surface, shall be equipped with screening that conforms to the requirements for monolithic glazing systems.

Exception: In monolithic and multiple-layer sloped glazing systems, the following applies:

1. Fully tempered glass installed without protective screens where glazed between intervening floors at a slope of 30 degrees (0.52 rad) or less from the vertical plane shall have the highest point of the glass 10 feet (3048 mm) or less above the walking surface.
2. Screens are not required below any glazing material, including annealed glass, where the walking surface below the glazing material is permanently protected from the risk of falling glass or the area below the glazing material is not a walking surface.
3. Any glazing material, including annealed glass, is permitted to be installed without screens in the sloped glazing systems of commercial or detached noncombustible greenhouses used exclusively for growing plants and not open to the public, provided that the height of the greenhouse at the ridge does not exceed 30 feet (9144 mm) above grade.
4. Screens shall not be required within individual dwelling units in Groups R-2, R-3 and R-4 where fully tempered glass is used as single glazing or as both panes in an insulating glass unit, and the following conditions are met:
   - 4.1. Each pane of the glass is 16 square feet (1.5 m^2) or less in area.
   - 4.2. The highest point of the glass is 12 feet (3658 mm) or less above any walking surface or other accessible area.
   - 4.3. The glass thickness is $^3/_{16}$ inch (4.8 mm) or less.
5. Screens shall not be required for laminated glass with a 15-mil (0.38 mm) polyvinyl butyral (or equivalent) interlayer used within individual dwelling units in Groups R-2, R-3 and R-4 within the following limits:
   - 5.1. Each pane of glass is 16 square feet (1.5 m^2) or less in area.
   - 5.2. The highest point of the glass is 12 feet (3658 mm) or less above a walking surface or other accessible area.

2405.4 Framing. In Type I and II construction, sloped glazing and skylight frames shall be constructed of noncombustible materials. In structures where acid fumes deleterious to metal are incidental to the use of the buildings, approved pressure-treated wood or other approved noncorrosive materials are permitted to be used for sash and frames. Framing supporting sloped glazing and skylights shall be designed to resist the tributary roof loads in Chapter 16. Skylights set at an angle of less than 45 degrees (0.79 rad) from the horizontal plane shall be mounted at least 4 inches (102 mm) above the plane of the roof on a curb constructed as required for the frame. Skylights shall not be installed in the plane of the roof where the roof pitch is less than 45 degrees (0.79 rad) from the horizontal.

Exception: Installation of a skylight without a curb shall be permitted on roofs with a minimum slope of 14 degrees (three units vertical in 12 units horizontal) in Group R-3 occupancies. All unit skylights installed in a roof with a pitch flatter than 14 degrees (0.25 rad) shall be mounted at least 4 inches (102 mm) above the plane of the roof on a curb constructed as required for the frame unless otherwise specified in the manufacturer's installation instructions.

2405.5 Unit skylights. Unit skylights shall be tested and labeled as complying with AAMA/WDMA/CSA 101/I.S.2/A440. The label shall state the name of the manufacturer, the approved labeling agency, the product designation and the performance grade rating as specified in AAMA/WDMA/CSA 101/I.S.2/A440. If the product manufacturer has chosen to have the performance grade of the skylight rated separately for positive and negative design pressure, then the label shall state both performance grade ratings as specified in AAMA/WDMA/CSA 101/I.S.2/A440 and the skylight shall comply with Section 2405.5.2. If the skylight is not rated separately for positive and negative pressure, then the performance grade rating shown on the label shall be the performance grade rating determined in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 for both positive and negative design pressure and the skylight shall conform to Section 2405.5.1.

2405.5.1 Unit skylights rated for the same performance grade for both positive and negative design pressure. The design of unit skylights shall be based on the following equation:

$$F_g \leq PG \qquad \textbf{(Equation 24-13)}$$

where:

F_g = Maximum load on the skylight determined from Equations 24-2 through 24-4 in Section 2404.2.

PG = Performance grade rating of the skylight.

2405.5.2 Unit skylights rated for separate performance grades for positive and negative design pressure. The design of unit skylights rated for performance grade for both positive and negative design pressures shall be based on the following equations:

$$F_{gi} \leq PG_{Pos} \qquad \textbf{(Equation 24-14)}$$

$$F_{go} \leq PG_{Neg} \qquad \textbf{(Equation 24-15)}$$

where:

PG_{Pos} = Performance grade rating of the skylight under positive design pressure;

PG_{Neg} = Performance grade rating of the skylight under negative design pressure; and

F_{gi} and F_{go} are determined in accordance with the following:

For $W_o \geq D$,

where:

W_o = Outward wind force, psf (kN/m^2) as calculated in Section 1609.

D = The dead weight of the glazing, psf (kN/m^2) as determined in Section 2404.2 for glass, or by the weight of the plastic, psf (kN/m^2) for plastic glazing.

F_{gi} = Maximum load on the skylight determined from Equations 24-3 and 24-4 in Section 2404.2.

F_{go} = Maximum load on the skylight determined from Equation 24-2.

For $W_o < D$,

where:

W_o = Is the outward wind force, psf (kN/m^2) as calculated in Section 1609.

D = The dead weight of the glazing, psf (kN/m^2) as determined in Section 2404.2 for glass, or by the weight of the plastic for plastic glazing.

F_{gi} = Maximum load on the skylight determined from Equations 24-2 through 24-4 in Section 2404.2.

F_{go} = 0.

SECTION 2406 SAFETY GLAZING

2406.1 Human impact loads. Individual glazed areas, including glass mirrors, in hazardous locations as defined in Section 2406.3 shall comply with Sections 2406.1.1 through 2406.1.4.

2406.1.1 CPSC 16 CFR 1201. Except as provided in Sections 2406.1.2 through 2406.1.4, all glazing shall pass the test requirements of CPSC 16 CFR 1201, listed in Chapter 35. Glazing shall comply with the CPSC 16 CFR, Part 1201 criteria, for Category I or II as indicated in Table 2406.1.

2406.1.2 Plastic glazing. Plastic glazing shall meet the weathering requirements of ANSI Z97.1.

2406.1.3 Glass block. Glass-block walls shall comply with Section 2101.2.5.

2406.1.4 Louvered windows and jalousies. Louvered windows and jalousies shall comply with Section 2403.5.

2406.2 Identification of safety glazing. Except as indicated in Section 2406.2.1, each pane of safety glazing installed in hazardous locations shall be identified by a manufacturer's designation specifying who applied the designation, the manufacturer or installer and the safety glazing standard with which it complies, as well as the information specified in Section 2403.1. The designation shall be acid etched, sand blasted, ceramic fired, laser etched, embossed or of a type that once applied, cannot be removed without being destroyed. A label as defined in Section 1702.1 and meeting the requirements of this section shall be permitted in lieu of the manufacturer's designation.

Exceptions:

1. For other than tempered glass, manufacturer's designations are not required, provided the building official

TABLE 2406.1
MINIMUM CATEGORY CLASSIFICATION OF GLAZING

EXPOSED SURFACE AREA OF ONE SIDE OF ONE LITE	GLAZING IN STORM OR COMBINATION DOORS (Category class)	GLAZING IN DOORS (Category class)	GLAZED PANELS REGULATED BY ITEM 7 OF SECTION 2406.3 (Category class)	GLAZED PANELS REGULATED BY ITEM 6 OF SECTION 2406.3 (Category class)	DOORS AND ENCLOSURES REGULATED BY ITEM 5 OF SECTION 2406.3 (Category class)	SLIDING GLASS DOORS PATIO TYPE (Category class)
9 square feet or less	I	I	No requirement	I	II	II
More than 9 square feet	II	II	II	II	II	II

For SI: 1 square foot = 0.0929m^2.

approves the use of a certificate, affidavit or other evidence confirming compliance with this code.

2. Tempered spandrel glass is permitted to be identified by the manufacturer with a removable paper designation

2406.2.1 Multilight assemblies. Multilight glazed assemblies having individual lights not exceeding 1 square foot (0.09 m^2) in exposed areas shall have at least one light in the assembly marked as indicated in Section 2406.2. Other lights in the assembly shall be marked "CPSC 16 CFR 1201."

2406.3 Hazardous locations. The following shall be considered specific hazardous locations requiring safety glazing materials:

1. Glazing in swinging doors except jalousies (see Section 2406.3.1).
2. Glazing in fixed and sliding panels of sliding door assemblies and panels in sliding and bifold closet door assemblies.
3. Glazing in storm doors.
4. Glazing in unframed swinging doors.
5. Glazing in doors and enclosures for hot tubs, whirlpools, saunas, steam rooms, bathtubs and showers. Glazing in any portion of a building wall enclosing these compartments where the bottom exposed edge of the glazing is less than 60 inches (1524 mm) above a standing surface.
6. Glazing in an individual fixed or operable panel adjacent to a door where the nearest exposed edge of the glazing is within a 24-inch (610 mm) arc of either vertical edge of the door in a closed position and where the bottom exposed edge of the glazing is less than 60 inches (1524 mm) above the walking surface.

   Exceptions:

   1. Panels where there is an intervening wall or other permanent barrier between the door and glazing.
   2. Where access through the door is to a closet or storage area 3 feet (914 mm) or less in depth. Glazing in this application shall comply with Section 2406.3, Item 7.
   3. Glazing in walls perpendicular to the plane of the door in a closed position, other than the wall towards which the door swings when opened, in one- and two-family dwellings or within dwelling units in Group R-2.

7. Glazing in an individual fixed or operable panel, other than in those locations described in preceding Items 5 and 6, which meets all of the following conditions:

   7.1. Exposed area of an individual pane greater than 9 square feet (0.84 m^2);

   7.2. Exposed bottom edge less than 18 inches (457 mm) above the floor;

   7.3. Exposed top edge greater than 36 inches (914 mm) above the floor; and

   7.4. One or more walking surface(s) within 36 inches (914 mm) horizontally of the plane of the glazing.

   Exception: Safety glazing for Item 7 is not required for the following installations:

   1. A protective bar $1^1/_2$ inches (38 mm) or more in height, capable of withstanding a horizontal load of 50 pounds plf (730 N/m) without contacting the glass, is installed on the accessible sides of the glazing 34 inches to 38 inches (864 mm to 965 mm) above the floor.
   2. The outboard pane in insulating glass units or multiple glazing where the bottom exposed edge of the glass is 25 feet (7620 mm) or more above any grade, roof, walking surface or other horizontal or sloped (within 45 degrees of horizontal) (0.78 rad) surface adjacent to the glass exterior.

8. Glazing in guards and railings, including structural baluster panels and nonstructural in-fill panels, regardless of area or height above a walking surface.
9. Glazing in walls and fences enclosing indoor and outdoor swimming pools, hot tubs and spas where all of the following conditions are present:

   9.1. The bottom edge of the glazing on the pool or spa side is less than 60 inches (1524 mm) above a walking surface on the pool or spa side of the glazing; and

   9.2. The glazing is within 60 inches (1524 mm) horizontally of the water's edge of a swimming pool or spa.

10. Glazing adjacent to stairways, landings and ramps within 36 inches (914 mm) horizontally of a walking surface; when the exposed surface of the glass is less than 60 inches (1524 mm) above the plane of the adjacent walking surface.
11. Glazing adjacent to stairways within 60 inches (1524 mm) horizontally of the bottom tread of a stairway in any direction when the exposed surface of the glass is less than 60 inches (1524 mm) above the nose of the tread.

    Exception: Safety glazing for Item 10 or 11 is not required for the following installations where:

    1. The side of a stairway, landing or ramp which has a guardrail or handrail, including balusters or in-fill panels, complying with the provisions of Sections 1013 and 1607.7; and
    2. The plane of the glass is greater than 18 inches (457 mm) from the railing.

2406.3.1 Exceptions. The following products, materials and uses shall not be considered specific hazardous locations:

1. Openings in doors through which a 3-inch (76 mm) sphere is unable to pass.
2. Decorative glass in Section 2406.3, Item 1, 6 or 7.
3. Glazing materials used as curved glazed panels in revolving doors.
4. Commercial refrigerated cabinet glazed doors.
5. Glass-block panels complying with Section 2101.2.5.
6. Louvered windows and jalousies complying with the requirements of Section 2403.5.
7. Mirrors and other glass panels mounted or hung on a surface that provides a continuous backing support.

2406.4 Fire department access panels. Fire department glass access panels shall be of tempered glass. For insulating glass units, all panes shall be tempered glass.

SECTION 2407
GLASS IN HANDRAILS AND GUARDS

2407.1 Materials. Glass used as a handrail assembly or a guard section shall be constructed of either single fully tempered glass, laminated fully tempered glass or laminated heat-strengthened glass. Glazing in railing in-fill panels shall be of an approved safety glazing material that conforms to the provisions of Section 2406.1.1. For all glazing types, the minimum nominal thickness shall be $^1/_4$ inch (6.4 mm). Fully tempered glass and laminated glass shall comply with Category II of CPSC 16 CFR 1201, listed in Chapter 35.

2407.1.1 Loads. The panels and their support system shall be designed to withstand the loads specified in Section 1607.7. A safety factor of four shall be used.

2407.1.2 Support. Each handrail or guard section shall be supported by a minimum of three glass balusters or shall be otherwise supported to remain in place should one baluster panel fail. Glass balusters shall not be installed without an attached handrail or guard.

2407.1.3 Parking garages. Glazing materials shall not be installed in handrails or guards in parking garages except for pedestrian areas not exposed to impact from vehicles.

SECTION 2408
GLAZING IN ATHLETIC FACILITIES

2408.1 General. Glazing in athletic facilities and similar uses subject to impact loads, which forms whole or partial wall sections or which is used as a door or part of a door, shall comply with this section.

2408.2 Racquetball and squash courts.

2408.2.1 Testing. Test methods and loads for individual glazed areas in racquetball and squash courts subject to impact loads shall conform to those of CPSC 16 CFR, Part 1201, listed in Chapter 35, with impacts being applied at a height of 59 inches (1499 mm) above the playing surface to an actual or simulated glass wall installation with fixtures, fittings and methods of assembly identical to those used in practice.

Glass walls shall comply with the following conditions:

1. A glass wall in a racquetball or squash court, or similar use subject to impact loads, shall remain intact following a test impact.
2. The deflection of such walls shall not be greater than $1^1/_2$ inches (38 mm) at the point of impact for a drop height of 48 inches (1219 mm).

Glass doors shall comply with the following conditions:

1. Glass doors shall remain intact following a test impact at the prescribed height in the center of the door.
2. The relative deflection between the edge of a glass door and the adjacent wall shall not exceed the thickness of the wall plus $^1/_2$ inch (12.7 mm) for a drop height of 48 inches (1219 mm).

2408.3 Gymnasiums and basketball courts. Glazing in multipurpose gymnasiums, basketball courts and similar athletic facilities subject to human impact loads shall comply with Category II of CPSC 16 CFR 1201, listed in Chapter 35.

SECTION 2409
GLASS IN ELEVATOR HOISTWAY

2409.1 Glass in elevator enclosures. Glass in elevator enclosures shall be laminated glass conforming to ANSI Z97.1 or 16 CFR Part 1201. Markings as specified in the applicable standard shall be on each separate piece of glass and shall remain visible after installation.

SECTION 2410
HIGH-VELOCITY HURRICANE ZONES — GENERAL

2410.1 Exterior wall cladding, surfacing and glazing, where provided, shall be as set forth in Sections 2410 through 2415.

2410.2 Exterior wall cladding, surfacing and glazing shall be designed and constructed to sufficiently resist the full pressurization from the wind loads prescribed in Chapter 16 (High-Velocity Hurricane Zones) and the concentrated loads that result from hurricane-generated wind-borne debris.

1. Exterior wall cladding, surfacing and glazing, within the lowest 30 feet (9.1 m) of the exterior building walls shall be of sufficient strength to resist large missile impacts as outlined in Chapter 16 (High-Velocity Hurricane Zones).
2. Exterior wall cladding, surfacing and glazing located above the lowest 30 feet (9.1 mm) of the exterior building walls shall be of sufficient strength to resist small missile impacts as outlined in Chapter 16 (High-Velocity Hurricane Zones).

Exception: Exterior wall cladding, surfacing and glazing when protected by fixed, operable or portable shutters or screens which have product approval to resist full pressurization from wind loads as well as large and small missile impacts as outlined in the high-velocity hurricane provisions of Chapter 16, without deforming to the point where the substrate being protected is compromised.

2410.3 Workmanship. Cladding and glazing shall be in conformance with the tolerances, quality and methods of construction as set forth in the standard referenced in Chapter 35.

2410.4 All exterior wall cladding, surfacing, garage doors, skylights, operative and inoperative windows shall have Product Approval.

SECTION 2411 HIGH-VELOCITY HURRICANE ZONES—WINDOWS, DOORS, GLASS AND GLAZING

2411.1 General.

2411.1.1 Windows, doors, glass and glazing shall be as set forth in this section.

2411.1.2 Glass shall comply with ASTM C 1036 requirements for flat glass Type I and II and GSA DD-G-451c *Standard for Glass, Flat and Corrugated, for Glazing Mirrors and Other Uses.*

2411.1.3 Tempered glass shall comply with 16 CFR 1201.

2411.1.4 Transparent and obscure safety glazing shall conform to the *Performance Specifications and Methods of Test for Transparent Safety Glazing Materials Used in Buildings, ANSI Z 97.1.*

2411.1.5 Heat-strengthened and ceramic-coated spandrel glass shall comply with ASTM C 1048.

2411.1.6 Wired glass shall comply with ANSI Z 97.I and shall only be used in fire doors and in glazed panels where safety glazing is not required.

2411.1.7 Installed glass shall not be less than Single-Strength B quality unless otherwise approved by the building official, and where edges are exposed they shall be seamed or ground.

2411.1.8 Where a light of glass is of such height above grade that the top 50 percent or more is in a zone of greater wind load, the area of the entire light shall be limited as for the greater height above grade.

2411.1.9 Replacement of any glazing or part thereof shall be designed and constructed in accordance with Chapter 34, Existing Buildings Provisions for High-Velocity Hurricane Zones.

2411.1.10 Replacement of glazing of more than one light or more than 30 percent of the total area glazed shall conform to the requirements of the section.

2411.1.11 Fixed glazing used as an exterior component shall require product approval. Rational analysis by a Florida-registered engineer or architect may be accepted when the actual pressure and geometry conditions differ from the conditions shown in the approval.

2411.2 Fixed glass in exterior walls.

2411.2.1 Limits of size of glass.

2411.2.1.1 The minimum thickness of annealed float glazing materials used in exterior walls shall be determined and shall not be less than as set forth in ASTM E 1300.

2411.2.1.2 For glazing materials other than annealed float use the glazing material resistance factors used in ASTM E 1300.

2411.2.1.3 Corrugated glass and other special glass shall be limited to spans determined by analysis and test to resist the loads set forth in Chapter 16 (High Wind Zones) based on fiber stresses not exceeding 4000 psi (27.58 MPa).

2411.2.1.4 Glass block shall have product approval.

2411.3 Doors and operative windows in exterior walls.

2411.3.1 Design and approval.

2411.3.1.1 The design and approval of sliding doors, swinging doors and operative windows in exterior walls, including the supporting members shall be based on the proposed use-height above grade in accordance with Chapter 16 (High-Velocity Hurricane Zones).

2411.3.1.2 Maximum glass sizes shall comply with ASTM E 1300.

2411.3.1.3 Glazing in sliding and in swinging doors shall be safety-glazing complying with 16 CFR 1201, *Safety Standard for architectural glazing Materials, Consumer Product Safety Commission,* and as described in Sections 2411.3.1.3.1 through 2411.3.1.3.5.

2411.3.1.3.1 Doors containing glazing material not greater than 9 square feet (0.84 m^2) in surface area shall be classified as Category I glazing products.

2411.3.1.3.2 Doors, bath and shower enclosures, and sliding glass doors containing glazing material greater than 9 square feet (0.84 m^2) in surface area shall be classified as Category II glazing products.

2411.3.1.3.3 Category I glazing products shall be capable of withstanding a 150 foot-pound (102 N-m) impact test.

2411.3.1.3.4 Category II glazing products shall be capable of withstanding a 400 foot-pound (542 N-m) impact test.

2411.3.1.3.5 Doors shall be designed to be readily operative without contact with the glass.

2411.3.1.4 The architect or professional engineer of record shall be required to specify the design wind pressure, determined in accordance with Chapter 16 (High-Velocity Hurricane Zones), for all garage doors, skylights operative windows and fixed glazing. The design wind pressure for each component of the exterior building surface, shall be incorporated into the building design drawing so as to allow the respective manufacturer to size the prefabricated assembly for the proper wind pressures.

2411.3.1.5 Exterior garage doors shall be designed and constructed to actively or passively lock in the closed position when subjected to a uniform lateral pressure in excess of 50 percent of the design wind pressure as prescribed in Chapter 16 (High-Velocity Hurricane Zones).

2411.3.1.6 The architect or professional engineer of record shall be required to detail on the drawings submitted for permit, rough opening dimensions, supporting framework, method of attachment and waterproofing procedures for all garage doors, passage doors, skylights, operative and inoperative windows in exterior walls. Said framework and method of attachment shall be designed and constructed so as to sufficiently resist the design wind pressures as outlined in Chapter 16 (High-Velocity Hurricane Zones).

Exception: When detailed engineered shop drawings, along with the notices of product approval, produced by the manufacturer's specialty engineer and approved by the architect or professional engineer of record, are admitted at the time of permit application, which completely identifies rough openings, supporting framework, method of attachment and waterproofing procedures are prepared and bear the signature and seal of a professional engineer.

2411.3.2 Tests.

2411.3.2.1 Operative window and door assemblies shall be tested in accordance with the requirements of this section, TAS 202 and provisions from ANSI/AAMA/MWWDA 101/IS 2, and the forced entry prevention requirements of the American Architectural Manufacturers Association (AAMA) Sections 1302.5 and 1303.5.

Exceptions:

1. Door assemblies installed in nonhabitable areas where the door assembly and area are designed to accept water infiltration, need not be tested for water infiltration.
2. Door assemblies installed where the overhang (OH) ratio is equal to or more than 1 need not be tested for water infiltration. The overhang ratio shall be calculated by the following equation:

   OH ratio = OH Length/OH Height

   where:

   OH length = The horizontal measure of how far an overhang over a door projects out from door's surface.

   OH height = The vertical measure of the distance from the door's sill to the bottom of the overhang over a door.
3. Pass-through windows for serving from a single-family kitchen, where protected by a roof overhang of 5 feet (1.5 m) or more shall be exempted from the requirements of the water infiltration test.

2411.3.2.1.1 Glazed curtain wall, window wall and storefront systems shall be tested in accordance with the requirements of this Section and the laboratory test requirements of the American Architectural Manufacturers Association (AAMA) Standard 501, following test load sequence and test load duration in TAS 202.

2411.3.2.2 Such assemblies with permanent muntin bars shall be tested with muntin bars in place.

2411.3.2.3 Such assemblies shall be installed in accordance with the conditions of test and approval.

2411.3.2.4 Test loads for inward and outward pressures shall be equal to the velocity pressures for the appropriate height in accordance with Chapter 16 (High-Velocity Hurricane Zones) as further modified by a factor of 1.5.

2411.3.2.5 Comparative analysis of operative windows and glazed doors may be made provided the proposed unit complies with the following:

1. Shall always be compared with a tested and currently approved unit.
2. Varies only in width, height and/or load requirements.
3. Shall not exceed 100 percent of the proportional deflection for fiber stress of the intermediate members of the approved unit.
4. Shall conform as to extruded members, reinforcement and in all other ways with the tested approved unit.
5. Shall not exceed 100 percent of the concentrated load at the juncture of the intermediate members and the frame of the approved unit.
6. Shall not permit more air and water infiltration than the approved unit based on the height above grade.
7. Compared unit shall not exceed the maximum cyclic pressure when tested per TAS 203.

2411.3.2.6 Comparative analysis of fixed glass windows may be made provided the proposed unit complies with the following:

1. Shall always be compared with a tested and currently approved unit.
2. Varies only in width, height and/or load requirements.
3. The design is identical in all respects. e.g., extrusions, glazing system, joinery, fasteners, etc.
4. Shall not permit more air and water infiltration than the approved unit based on height above grade.
5. The maximum uniform load distribution (ULD) of any side is equal to the uniform load carried by the side divided by the length of the side.
6. The ULD of any member must not exceed the ULD of the corresponding member of the tested window.
7. The uniform load distribution on each member shall be calculated in accordance to Section 2, Engineering Design Rules, of the AAMA 103.3 *Procedural Guide*.
8. Compared unit shall not exceed the maximum cyclic pressure when tested per TAS 203.

2411.3.3 Construction details. Construction details for fixed glass shall comply with the requirements of this paragraph except that structural glazing as defined in Section 202 need not comply with this section, but shall comply with Section 2415.

2411.3.3.1 Each light of fixed glass more than 3 feet (914 mm) in width shall have two approved setting blocks or approved suspension clamps. Setting blocks shall be Neoprene 70-90 Shore A durometer hardness or approved equal.

2411.3.3.2 Fixed glass lights shall be set in corrosion-resistant metal frames and shall comply with applicable requirements of Chapter 16 (High-Velocity Hurricane Zones) for wind loads, allowable stresses and load tests. Fixed glass lights may be set in wood, metal or concrete frames as permitted for the types of construction by Chapter 3 through Chapter 6.

2411.3.3.3 Wood shall have been preservative treated or shall be of a durable species as defined in Section 2326.2.

2411.3.3.4 Attachment shall be as set forth in Chapter 16 (High-Velocity Hurricane Zones) and shall be corrosion-resistant.

2411.3.3.5 Glass in fixed lights shall be securely and continuously supported at the perimeter of each sheet unless the design is based on one or more unsupported edges. Supporting members such as division bars and mullions shall be designed by rational analysis to support the wind pressures set forth in Chapter 16 (High-Velocity Hurricane Zones). Supporting bars shall be attached at the ends to resist the loads set forth in Chapter 16 (High-Velocity Hurricane Zones).

2411.3.3.6 The depth of the glazing rabbet and depth of engagement in the rabbet, for fixed glass, shall be based on consideration of the dimensional reduction from deflection and the dimensional changes caused by temperature.

2411.3.3.7 Exterior lite of glass in an insulated glass unit shall be safty glazed.

Exceptions:

1. Large missile impact-resistant glazed assemblies.
2. Nonmissile impact units protected with shutters.

2411.3.4 Gaskets used in glazing systems shall comply with the following standards as applicable:

1. ASTM C 864, Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
2. ASTM C 509, Elastomeric Cellular Preformed Gaskets and Sealing Material.
3. ASTM C 1115, Dense Elastomeric Silicone Rubber Gaskets and Accessories.
4. ASTM E 2203, Dense Thermoplastic Elastomers Used for Compression Seals, Gaskets, Setting Blocks, Spacers and Accessories.

2411.4 Glazed panel safeguards. Glazed panels shall be protected in accordance with this section.

2411.4.1 Where there is a drop of 4 feet (1219 mm) or more on the far side of fixed glazed panel 24 inches (610 mm) or more in width, the bottom of which is less than 36 inches (914 mm) above the near side walking surface, safeguards as set forth in Section 1618.4 shall be provided.

2411.4.2 Where there is a drop of less than 4 feet (1219 mm) on opposite sides of an operable or nonoperable glazed panel 24 inches (610 mm) or more in width and 9 square feet (0.84 m^2) or more in area, one of the following safeguards shall be provides where persons might walk into or through such glazing:

1. Safety glazing conforming to federal standard 16 CFR 1201.
2. An opaque bulkhead not less than 18 inches (457 mm) higher than the upper level.
3. A single horizontal bar of handrail strength requirements not less than $1^1/_2$ inches (38 mm) in width measured parallel to the plane of the glazing and located between 24 inches and 36 inches (610 and 914 mm) above the upper level.
4. A planter with plantings not less than 18 inches (457 mm) higher than the upper level.

2411.4.3 Glazed panels located adjacent to, or in doors, shall be of safety glazing, in accordance with the following:

1. All glazed panels through which a 3-inch-diameter (76 mm) sphere is able to pass.
2. In all occupancies, any glazing material adjacent to door within 48 inches (1219 mm) of the door in the closed position and below the top of the door.

Exceptions:

1. Wired glass in fire doors.
2. Leaded glass of 30 square inches (.02 m^2) or less.
3. Curved glass in revolving doors.
4. Commercial refrigerated cabinet doors.
5. A solar screen may serve as a safeguard where such screen complies with strength requirements of railings.

2411.5 Operable window safeguards. Operable windows shall be protected in accordance with this section.

2411.5.1 Where there is a drop of more than 4 feet (1219 mm) on the far side of such windows and the sill is less than 36 inch (914 mm) above the near side walking surface, safeguards shall be provided to prevent the fall of persons when such windows are open as set forth in Section 1618.4.

Exceptions:

1. Where the vent openings are 12 inches (305 mm) or less in least dimension and are restricted in operation to reject objects as required for safeguard in Section 1618.4.
2. Slats or grillwork constructed to comply with Standard OSHA-1910, set forth in Section 1618.4

or other construction approved by the building official, may be provided in lieu of other safeguards.

3. Where the near side of such windows is less than 4 inches (102 mm) above the floor and falling objects could present a hazard, toeboards shall be provided as required by 29 CFR 1910.
4. Alternate approved designs.

2411.5.2 Where the drop from such windows is less than 4 feet (1219 mm) or where such windows are adjacent to a door, the glazing shall comply with the Sections 2411.4.2 and 2411.4.3.

2411.6 Interior locations.

2411.6.1 Swinging or sliding doors of glass without a continuous frame shall be of only fully tempered glass not less than $^3/_8$ inch (9.5 mm) in thickness.

2411.6.2 Safeguards. The glazing in sliding and swinging doors and in shower to tub enclosures, including any glazing within 60 inches (1.5 m) of the finished floor surface in walls surrounding any tub or shower enclosure, shall be safety glazing as set forth in Section 2411.3.1.3 for Category II glazing products.

2411.6.3 Glass or mirrors immediately surrounding a bathtub or shower enclosure shall be safety glazing where the glass or mirrors are less than 60 inches (1.5 m) above the floor of the tub or the shower.

2411.6.4 The glazing in fixed panels adjacent to paths of egress shall comply with Section 2411.4.3.

2411.6.5 Glass shall not be solid painted or otherwise concealed where such painted glass may be mistaken for other construction materials.

2411.6.6 Glass mirrors of more than 9 square feet (0.84 m^2) in area that are used as surface finish material on walls in public spaces shall be directly secured to supports and shall not be hung.

2411.7 Safety glazing.

2411.7.1 Safety glazing, where required, shall be as set forth in this section.

2411.7.2 Safety glazing shall comply with the standard set forth in Section 2411.1.4 for transparent and obscure safety-glazing materials, and plastic glazing shall in addition comply with the specifications of Section 2411.7.3.

2411.7.3 Plastics, with or without reinforcing or acrylic modifiers shall comply with Section 2612, and consideration of dimension reduction caused by deflection and/or dimensional instability of the materials shall be given in the determination of the depth of the glazing rabbet and engagement of the plastic in the rabbet. Plastics shall be limited to spans determined by analysis and test to resist the loads set forth in Chapter 16 (High-Velocity Hurricane Zones).

2411.7.4 Glass louvered doors need not be safety glazed.

2411.8 Sloped glazing.

2411.8.1 Sloped glazing includes any installation of glass or other transparent, translucent or opaque glazing material installed at a slope of 15 degrees (0.26 rad) or more from the vertical plane. Glazing materials in skylights, roofs and sloped walls are included with this definition.

2411.8.2 Allowable glazing materials. Sloped glazing shall be any of the following materials subject to the limitations specified in Section 2411.8.3.

2411.8.2.1 For monolithic glazing systems, the glazing material of the single light or layer shall be laminated with a minimum 30 mil polyvinyl butyryl (or equivalent) interlayer, wire glass, approved plastic material meeting the requirements of this chapter, heat strengthened glass or fully tempered glass.

2411.8.2.2 For multiple glazing systems, each light or layer shall consist of any glazing materials specified in Section 2411.8.2.1.

2411.8.2.3 See Section 2612 for additional requirements for plastic skylights.

2411.8.3 Limitations. Heat strengthened and fully tempered glass when used in monolithic glazing systems shall have screens installed below the glazing material to protect building occupants from falling glass should breakage occur. The screens shall be capable of supporting the weight of the glass and shall be substantially supported below and installed within 4 inches (102 mm) of the glass. They shall be constructed of a noncombustible material not thinner than 0.0808 inch (2 mm) (12 B and S gauge) diameter with a mesh not larger than 1 inch by 1 inch (25 mm by 25 mm). In a corrosive atmosphere structurally equivalent corrosion-resistant screening materials shall be used. Heat-strengthened glass, fully tempered glass and wire glass, when used in multiple glazing systems as the bottom layer over the walking surface, shall be equipped with screening meeting the requirements for monolithic glazing systems.

Exceptions:

1. In monolithic and multiple-layer sloped glazing systems, any glazing material, including annealed glass, may be installed without required screens if the walking surface below the glazing material is permanently protected from the risk of falling glass or if the area below the glazing material is not a walking surface.
2. In monolithic and multiple layer sloped glazing systems, any glazing material, including annealed glass, may be installed in the sloped glazing systems of greenhouses (structures used primarily for growing plants) without screens provided the height of the penthouse at the ridge does not exceed 20 feet (6.1 m) above grade. Frames may be of wood construction in greenhouses located outside the fire district if the height of the sloped glazing does not exceed 20 feet (6.1 m) above grade. In other cases, noncombustible frames shall be used.

2411.8.4 Sloped glazed framing. In other than Types IV II-B and III-B construction, all sloped glazing skylight frames shall be constructed of noncombustible materials. In foundries or buildings where acid fumes deleterious to metal are incidental to the use of the building, approved pressure treated woods or other approved noncombustible material shall be permitted for sash and frames. All sloped glazing and skylights shall be designed for the roof and wind loads in Chapter 16 (High-Velocity Hurricane Zones). All skylights set at an angle of less than 45 degrees (0.79 rad) from the horizontal shall be mounted at least 4 inches (102 mm) above the planer of the roof on a curb construction as required for the frame. Sloped glazing may be installed in the plane of the roof where the roof pitch is greater than 45 degrees (0.79 rad) from the horizontal.

SECTION 2412 HIGH-VELOCITY HURRICANE ZONES—GLASS VENEER

2412.1 Glass veneer shall be as set forth in this section.

2412.2 Dimension. Glass veneer units shall be not less than $^{11}/_{32}$ inch (8.7 mm) in thickness. No unit shall be larger in area than 10 square feet (0.93 m^2) where 15 feet (4.6 m) or less above the grade directly below, nor larger than 6 square feet (0.56 m^2) where more than 15 feet (4.6 m) above the grade directly below.

2412.3 Attachment. Every glass veneer unit shall be attached to the backing with approved mastic cement and corrosion-resistant ties and shall be supported on shelf angles.

2412.3.1 Where more than 6 feet (1829 mm) above grade, veneer shall be supported by shelf angles, and ties shall be used in both horizontal and vertical joints.

2412.3.2 Below a point 6 feet (1829 mm) above grade, glass veneer shall rest on shelf angles. Veneering shall not be supported on construction which is not an integral part of the wall, and over sidewalks shall be supported on a shelf angle not less than $^1/_4$ inch (6.4 mm) above grade.

2412.3.3 All edges of glass veneer shall be ground.

2412.4 Mastic.

2412.4.1 The mastic shall cover not less than one-half of the area of the unit after the unit has been set in place and shall be neither less than $^1/_4$ inch (6.4 mm) nor more than $^1/_2$ inch (12.7 mm) in thickness.

2412.4.2 The mastic shall be insoluble in water and shall not lose its adhesive qualities when dry.

2412.4.3 Absorbent surfaces shall be sealed by a bonding coat before mastic is applied. The bonding coat shall be cohesive with the mastic.

2412.4.4 Glass veneer surfaces to which mastic is applied shall be clean and uncoated.

2412.4.5 Space between edges of glass veneer shall be filled uniformly with an approved type pointing compound.

2412.5 Shelf angles and ties.

2412.5.1 Shelf angles shall be of corrosion-resistant material capable of supporting four times the width of the supported veneer. The shelf angles shall be spaced vertically in alternate horizontal joints, but not more than 3 feet (914 mm) apart. Shelf angles shall be secured to the wall at intervals not exceeding 2 feet (610 mm) with corrosion-resistant bolts not less than $^1/_4$ inch (6.4 mm) diameter. Bolts shall be set in masonry and secured by lead shields.

2412.5.2 Ties shall be of corrosion resistant metal as manufactured especially for holding glass-veneer sheets to masonry surfaces. There shall be not less than one such approved tie for each 2 square feet (0.19 m^2) of veneer surface.

2412.6 Backing. Exterior glass veneer shall be applied only upon masonry, concrete or stucco.

2412.7 Expansion joints. Glass veneer units shall be separated from each other and from adjoining materials by an expansion joint at least $^1/_{16}$ inch (1.6 mm) in thickness. There shall be at least $^1/_{64}$ inch (0.4 mm) clearance between bolts and the adjacent glass.

SECTION 2413 HIGH-VELOCITY HURRICANE ZONES—STORM SHUTTERS/EXTERNAL PROTECTIVE DEVICES

2413.1 General. Unless exterior wall components including but not limited to structural glazing, doors and windows of enclosed buildings have specific Product Approval to preserve the enclosed building envelope against impact loads as set forth in Chapter 16 (High-Velocity Hurricane Zones), all such components shall be protected by product approved storm shutters.

2413.2 The storm shutters shall be designed and constructed to insure a minimum of 1 inch (25 mm) separation at maximum deflection with components and frames of components they are to protect unless the components and frame are specifically designed to receive the load of storm shutters, and shall be designed to resist the wind pressures as set forth in Chapter 16 (High-Velocity Hurricane Zones) by methods admitting of rational analysis based on established principles of design. Storm shutter shall also be designed to comply with the impact load requirements included within Chapter 16 (High-Velocity Hurricane Zones).

2413.3 The storm shutter design calculations and detailed drawings, including attachment to the main structure, shall be prepared by and bear the seal of a qualified Florida-registered delegated engineer, or if qualified to prepare such design, by the engineer or architect of record, which architect or engineer shall be proficient in structural design. The architect or engineer of record shall, in all instances, review and approve documents prepared by the delegated engineer.

2413.4 Storm shutters shall be approved by the certification agency and shall bear the name of the company engraved in every section of the system.

2413.5 Deflection shall not exceed the limits set forth in Chapter 16 (High-Velocity Hurricane Zones).

2413.6 Unless storm shutters are permanently attached to the main structure, all such storm shutters shall, where practicable, be neatly stored at all times in a designated and accessible area within the building.

2413.6.1 Shutters used to protect openings above the first story of any building or structure must be permanently installed and closable from the inside of the building or structure unless such openings are accessible without the use of a ladder or lift, or shutters can be installed from the interior of the building or structure.

Exception: Group R3 detached single-family residences not exceeding two stories.

2413.7 Storm shutters must completely cover an opening in all directions.

2413.7.1 On any side of an opening, the maximum side clearance between the shutter and a wall or inset surface shall be $^1/_4$ inch (6.4 mm). Any distance in excess of $^1/_4$ inch (6.4 mm) shall require end closure or shutter overlap, where applicable.

2413.7.2 Shutter overlap shall be a minimum of 1.5 times the side clearance between the shutter and wall.

2413.7.3 End closures shall be designed to resist wind loads specified in Chapter 16 (High-Velocity Hurricane Zones), based on rational analysis.

SECTION 2414
HIGH-VELOCITY HURRICANE ZONES—CURTAIN WALLS

2414.1 Scope. This section prescribes requirements for curtain walls of buildings or structures regulated by this code.

2414.2 Definition. A curtain wall is any prefabricated assembly of various components to enclose a building usually attached to and/or supported by the building frame other than a single door, or window, masonry units, poured in place concrete and siding of single membrane metal, wood or plastic.

2414.3 Curtain walls, as defined in Section 2414.2, shall be designed and constructed in accordance with the requirements of this section.

2414.4 Structural glazing in curtain walls shall also comply with the requirements of Section 2415.

2414.5 General.

2414.5.1 All structural elements of curtain wall systems and their attachments (including embedments) to the main structural frame shall be designed by and bear the seal of a qualified Florida-registered delegated engineer, or if qualified to prepare such design, by the engineer or architect of record, which architect or engineer shall be proficient in structural design. The engineer of record shall, in all instances, review and approve documents prepared by the delegated engineer.

2414.5.2 Curtain wall systems supported from more than two adjacent floors shall be designed to withstand all imposed loads without exceeding allowable stresses in the event of destruction or failure of any single span within the system. Documents for the main building permit shall include sufficient details describing the curtain wall system attachment to the main structure. This portion of the contract documents, if not prepared by the qualified engineer or architect of record, shall bear the signature and seal of the qualified Florida-registered delegated engineer charged with the responsibility for the design of the curtain wall system.

2414.5.3 Individual mullions acting as a continuous member shall transfer loads through supports from no more than three adjacent floors.

2414.5.4 Materials. The materials used in any curtain wall shall comply with the applicable provisions of this code.

2414.6 Fire protection.

2414.6.1 Curtain wall supports, spandrel panels, anchors and the connections at the intersection of the floor and wall shall be fire protected based on building distance separation as required in this code.

2414.6.2 Irrespective of distance separation, anchors, embedded hardware, connections at the intersection of the wall and floor and other connectors used to attach the curtain wall framing system to the building frame shall be provided with fire protection from the floor below with fire-resistant materials having a fire rating equivalent to that of the floor.

2414.6.3 Reserved.

2414.6.4 Openings between curtain wall systems and fire resistive floors shall be protected against the passage of fire and smoke in accordance with Section 2414.6.2

2414.6.5 Where fire safing is used to achieve such protection, it shall be installed in such a manner that it will remain in place for at least a duration equivalent to the fire-resistive rating of the floor system,

2414.7 Inspection. Curtain wall systems and their attachments to the main structure shall be inspected by a special inspector at both the point of assembly and the point of installation.

SECTION 2415
HIGH-VELOCITY HURRICANE ZONES—STRUCTURAL GLAZING SYSTEMS

2415.1 Scope. This section prescribes requirements for structural glazing systems of buildings or structures regulated by this code.

2415.2 Application.

2415.2.1 Structural glazing, as defined in Section 2414.2, shall be designed and constructed in accordance with the requirements of this section.

2415.2.2 Structural glazing systems used in curtain walls shall also comply with the requirements of Section 2414.

2415.3 Definition. The terms used in this section shall be defined as set forth in Section 202.

2415.4 Standards. Adhesives and sealants used in structural glazing systems shall comply with following standards:

ASTM C 794, Test Method for Adhesion-In-Peel of Elastomeric Joint Sealants.

ASTM C 920, Specification for Elastomeric Joint Sealants.

ASTM D 412, Test Methods for Rubber Properties in Tension.

ASTM D 624, Test Method for Rubber Property-Tear Resistance.

ASTM D 2240, Test Method for Rubber Property-Durometer Hardness.

Federal Specifications TT-S-001543A and TT-S-00230C.

ASTM E 331, Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors.

ASTM E 330, Test Method for Structural Performance of Exterior Windows, Curtain Walls and Doors.

2415.5 Design.

2415.5.1 General. Structural glazing systems shall be designed by and bear the seal of a Florida-registered professional engineer.

2415.5.2 Materials.

2415.5.2.1 Identification. All materials shall be clearly identified as to manufacturer and manufacturer's product number.

2415.5.2.2 Adhesives and sealants.

2415.5.2.2.1 Only approved silicone elastomer adhesives and sealants shall be used for fastening glass lights and other panels to curtain wall framing.

2415.5.2.2.2 Such adhesives and sealants shall be of a polymer that is 100-percent silicone.

2415.5.2.2.3 Adhesives and sealants shall have been tested in accordance with the standards set forth in Section 2415.4.

2415.5.3 Manufacturer's testing, recommendation and approval.

2415.5.3.1 Compatibility of all components and fabrication procedures of structural glazing systems shall be tested, approved and recommended in writing by the manufacturer of the adhesive; the manufacturer of the coating; whether it is anodized, baked or otherwise applied and the manufacturer of the glass panel.

2415.5.3.2 Manufacturer's testing, recommendation and approval shall address, but shall not be limited in scope by the following sections.

2415.5.3.2.1 The compatibility of the sealant with metal, glazing materials, shims, spacers, setting blocks, backer rods, gaskets and other materials.

2415.5.3.2.2 Adhesion to the designated substrates and adhesion of the substrates to the base metal.

2415.5.3.2.3 The design and structural capability of silicone joints and cross sections.

2415.5.4 Structural requirements.

2415.5.4.1 Design of structural seals.

2415.5.4.1.1 The design stress of the structural silicone shall not exceed 20 psi (138 kPa) for materials having a minimum strength of 100 psi (690 kPa) at the weakest element in the line of stress.

2415.5.4.1.2 Such design stress shall also provide for a safety factor of not less than 5.0.

2415.5.4.1.3 Safety factors greater than 5.0 shall be specified by the engineer when required or recommended by the manufacturer.

2415.5.4.1.4 The silicone structural seal shall have a maximum modulus of elasticity to allow no more than 25 percent movement of the joint width at 20 psi (138 kPa) stress.

2415.5.4.1.5 In insulating glass units, the secondary silicone seal shall be designed to withstand a minimum of one-half the design negative wind load applicable to the outboard lights.

2415.5.4.2 Bonding limits. Structural glazing shall be limited to adhesive bonding on one side or on two opposing sides of an infill glass lights or panel.

Exception: Three- or four-side bonding shall be permitted only when structural glazing units are shop fabricated and shop glazed.

2415.5.4.3 Job-site reglazing.

2415.5.4.3.1 Job-site replacement reglazing shall be permitted only when performed following a procedure approved in writing by the applicable structural silicone manufacturer.

2415.5.4.3.2 Replacement shall be performed only by individuals or firms approved or certified by the silicone manufacturer.

2415.6 Fire protection. Structural glazing in curtain walls shall be fire protected as required by Section 2414.6.

2415.7 Inspections, testing and recertification.

2415.7.1 A minimum of 1 percent of the structurally glazed panels shall be tested for load carrying capacity and sealant adhesion in accordance with Chapter 16 (High-Velocity Hurricane Zones) and ASTM E 330.

2415.7.2 Structural glazed panels shall be inspected by a Florida-registered architect or professional engineer for conformance with the approved design and installation procedures determined by the authority having jurisdiction prior to the erection of such panels and after the seal curing period established by the silicone manufacturer.

2415.7.3 It shall be the responsibility of the contractor to verify the adhesion of the cured sealant periodically throughout the application to assure compliance with the manufacturer's specifications and quality of application.

2415.7.4 Structural glazing systems on threshold buildings shall be recertified by the owner as specified by the authority having jurisdiction at six month intervals for the first year after installation. Subsequently, such systems shall be recertified every five years at regular intervals.

2415.7.5 Such recertifications shall determine the structural condition and adhesion capacity of the silicone sealant.

CHAPTER 25
GYPSUM BOARD AND PLASTER

SECTION 2501 GENERAL

2501.1 Scope.

2501.1.1 General. Provisions of this chapter shall govern the materials, design, construction and quality of gypsum board, lath, gypsum plaster and cement plaster.

Exception: Buildings and structures located within the high-velocity hurricane zone shall comply with the provisions of Sections 2514 through 2520.

2501.1.2 Performance. Lathing, plastering and gypsum board construction shall be done in the manner and with the materials specified in this chapter, and when required for fire protection, shall also comply with the provisions of Chapter 7.

2501.1.3 Other materials. Other approved wall or ceiling coverings shall be permitted to be installed in accordance with the recommendations of the manufacturer and the conditions of approval.

SECTION 2502 DEFINITIONS

2502.1 Definitions. The following words and terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meanings shown herein.

CEMENT PLASTER. A mixture of portland or blended cement, portland cement or blended cement and hydrated lime, masonry cement or plastic cement and aggregate and other approved materials as specified in this code.

EXTERIOR SURFACES. Weather-exposed surfaces.

GYPSUM BOARD. Gypsum wallboard, gypsum sheathing, gypsum base for gypsum veneer plaster, exterior gypsum soffit board, predecorated gypsum board or water-resistant gypsum backing board complying with the standards listed in Tables 2506.2, 2507.2 and Chapter 35.

GYPSUM PLASTER. A mixture of calcined gypsum or calcined gypsum and lime and aggregate and other approved materials as specified in this code.

GYPSUM VENEER PLASTER. Gypsum plaster applied to an approved base in one or more coats normally not exceeding $^1/_4$ inch (6.4 mm) in total thickness.

INTERIOR SURFACES. Surfaces other than weather-exposed surfaces.

WEATHER-EXPOSED SURFACES. Surfaces of walls, ceilings, floors, roofs, soffits and similar surfaces exposed to the weather except the following:

1. Ceilings and roof soffits enclosed by walls, fascia, bulkheads or beams that extend a minimum of 12 inches (305 mm) below such ceiling or roof soffits.
2. Walls or portions of walls beneath an unenclosed roof area, where located a horizontal distance from an open exterior opening equal to at least twice the height of the opening.
3. Ceiling and roof soffits located a minimum horizontal distance of 10 feet (3048 mm) from the outer edges of the ceiling or roof soffits.

WIRE BACKING. Horizontal strands of tautened wire attached to surfaces of vertical supports which, when covered with the building paper, provide a backing for cement plaster.

SECTION 2503 INSPECTION

2503.1 Inspection. Lath and gypsum board shall be inspected in accordance with Section 109.3.5.

SECTION 2504 VERTICAL AND HORIZONTAL ASSEMBLIES

2504.1 Scope. The following requirements shall be met where construction involves gypsum board, lath and plaster in vertical and horizontal assemblies.

2504.1.1 Wood framing. Wood supports for lath or gypsum board, as well as wood stripping or furring, shall not be less than 2 inches (51 mm) nominal thickness in the least dimension.

Exception: The minimum nominal dimension of wood furring strips installed over solid backing shall not be less than 1 inch by 2 inches (25 mm by 51 mm).

2504.1.2 Studless partitions. The minimum thickness of vertically erected studless solid plaster partitions of $^3/_8$-inch (9.5 mm) and $^3/_4$-inch (19.1 mm) rib metal lath or $^1/_2$-inch-thick (12.7 mm) long-length gypsum lath and gypsum board partitions shall be 2 inches (51 mm).

SECTION 2505 SHEAR WALL CONSTRUCTION

2505.1 Resistance to shear (wood framing). Wood-framed shear walls sheathed with gypsum board, lath and plaster shall be designed and constructed in accordance with Section 2306.4 and are permitted to resist wind loads.

2505.2 Resistance to shear (steel framing). Cold-formed steel-framed shear walls sheathed with gypsum board and constructed in accordance with the materials and provisions of Section 2210.5 are permitted to resist wind loads.

SECTION 2506
GYPSUM BOARD MATERIALS

2506.1 General. Gypsum board materials and accessories shall be identified by the manufacturer's designation to indicate compliance with the appropriate standards referenced in this section and stored to protect such materials from the weather.

2506.2 Standards. Gypsum board materials shall conform to the appropriate standards listed in Table 2506.2 and Chapter 35 and, where required for fire protection, shall conform to the provisions of Chapter 7.

TABLE 2506.2
GYPSUM BOARD MATERIALS AND ACCESSORIES

MATERIAL	STANDARD
Accessories for gypsum board	ASTM C 1047
Adhesives for fastening gypsum wallboard	ASTM C 557
Exterior soffit board	ASTM C 931
Fiber-reinforced gypsum panels	ASTM C 1278
Glass mat gypsum backing panel	ASTM C 1178
Glass mat gypsum substrate	ASTM C 1177
Gypsum backing board and gypsum shaftliner board	ASTM C 442
Gypsum ceiling board	ASTM C 1395
Gypsum sheathing	ASTM C 79
Gypsum wallboard	ASTM C 36
Joint reinforcing tape and compound	ASTM C 474; C 475
Nails for gypsum boards	ASTM C 514, F 547, F 1667
Predecorated gypsum board	ASTM C 960
Steel screws	ASTM C 954; C 1002
Steel studs, load bearing	ASTM C 955
Steel studs, nonload bearing	ASTM C 645
Standard specification for gypsum board	ASTM C 1396
Testing gypsum and gypsum products	ASTM C 22; C 472; C 473
Water-resistant gypsum backing board	ASTM C 630

2506.2.1 Other materials. Metal suspension systems for acoustical and lay-in panel ceilings shall conform with ASTM C 635 listed in Chapter 35.

SECTION 2507
LATHING AND PLASTERING

2507.1 General. Lathing and plastering materials and accessories shall be marked by the manufacturer's designation to indicate compliance with the appropriate standards referenced in this section and stored in such a manner to protect them from the weather.

2507.2 Standards. Lathing and plastering materials shall conform to the standards listed in Table 2507.2 and Chapter 35 and, where required for fire protection, shall also conform to the provisions of Chapter 7.

TABLE 2507.2
LATH, PLASTERING MATERIALS AND ACCESSORIES

MATERIAL	STANDARD
Accessories for gypsum veneer base	ASTM C 1047
Blended cement	ASTM C 595
Exterior plaster bonding compounds	ASTM C 932
Gypsum base for veneer plasters	ASTM C 588
Gypsum casting and molding plaster	ASTM C 59
Gypsum Keene's cement	ASTM C 61
Gypsum lath	ASTM C 37
Gypsum plaster	ASTM C 28
Gypsum veneer plaster	ASTM C 587
Interior bonding compounds, gypsum	ASTM C 631
Lime plasters	ASTM C 5; C 206
Masonry cement	ASTM C 91
Metal lath	ASTM C 847
Plaster aggregates Sand Perlite Vermiculite	 ASTM C 35; C 897 ASTM C 35 ASTM C 35
Plastic cement	ASTM C 1328
Portland cement	ASTM C 150
Steel screws	ASTM C 1002; C 954
Steel studs and track	ASTM C 645; C 955
Welded wire lath	ASTM C 933
Woven wire plaster base	ASTM C 1032

SECTION 2508
GYPSUM CONSTRUCTION

2508.1 General. Gypsum board and gypsum plaster construction shall be of the materials listed in Tables 2506.2 and 2507.2. These materials shall be assembled and installed in compliance with the appropriate standards listed in Tables 2508.1 and 2511.1, and Chapter 35.

TABLE 2508.1
INSTALLATION OF GYPSUM CONSTRUCTION

MATERIAL	STANDARD
Gypsum board	GA-216; ASTM C 840
Gypsum sheathing	ASTM C 1280
Gypsum veneer base	ASTM C 844
Interior lathing and furring	ASTM C 841
Steel framing for gypsum boards	ASTM C 754; C 1007

2508.2 Limitations. Gypsum wallboard or gypsum plaster shall not be used in any exterior surface where such gypsum construction will be exposed directly to the weather. Gypsum wallboard shall not be used where there will be direct exposure to water or continuous high humidity conditions. Gypsum sheathing shall be installed on exterior surfaces in accordance with ASTM C 1280.

2508.2.1 Weather protection. Gypsum wallboard, gypsum lath or gypsum plaster shall not be installed until weather protection for the installation is provided.

2508.3 Single-ply application. Edges and ends of gypsum board shall occur on the framing members, except those edges and ends that are perpendicular to the framing members. Edges and ends of gypsum board shall be in moderate contact except in concealed spaces where fire-resistance-rated construction, shear resistance or diaphragm action is not required.

2508.3.1 Floating angles. Fasteners at the top and bottom plates of vertical assemblies, or the edges and ends of horizontal assemblies perpendicular to supports, and at the wall line are permitted to be omitted except on shear resisting elements or fire-resistance-rated assemblies. Fasteners shall be applied in such a manner as not to fracture the face paper with the fastener head.

2508.4 Joint treatment. Gypsum board fire-resistance-rated assemblies shall have joints and fasteners treated.

Exception: Joint and fastener treatment need not be provided where any of the following conditions occur:

1. Where the gypsum board is to receive a decorative finish such as wood paneling, battens, acoustical finishes or any similar application that would be equivalent to joint treatment.
2. On single-layer systems where joints occur over wood framing members.
3. Square edge or tongue-and-groove edge gypsum board (V-edge), gypsum backing board or gypsum sheathing.
4. On multilayer systems where the joints of adjacent layers are offset from one to another.
5. Assemblies tested without joint treatment.

2508.5 Horizontal gypsum board diaphragm ceilings. Gypsum board shall be permitted to be used on wood joists to create a horizontal diaphragm ceiling in accordance with Table 2508.5.

2508.5.1 Diaphragm proportions. The maximum allowable diaphragm proportions shall be $1^{1}/_{2}$:1 between shear resisting elements. Rotation or cantilever conditions shall not be permitted.

2508.5.2 Installation. Gypsum board used in a horizontal diaphragm ceiling shall be installed perpendicular to ceiling framing members. End joints of adjacent courses of gypsum board shall not occur on the same joist.

2508.5.3 Blocking of perimeter edges. All perimeter edges shall be blocked using a wood member not less than 2-inch by 6-inch (51 mm by 159 mm) nominal dimension. Blocking material shall be installed flat over the top plate of the wall to provide a nailing surface not less than 2 inches (51 mm) in width for the attachment of the gypsum board.

2508.5.4 Fasteners. Fasteners used for the attachment of gypsum board to a horizontal diaphragm ceiling shall be as defined in Table 2508.5. Fasteners shall be spaced not more than 7 inches (178 mm) on center (o.c.) at all supports, including perimeter blocking, and not more than $^{3}/_{8}$ inch (9.5 mm) from the edges and ends of the gypsum board.

2508.5.5 Lateral force restrictions. Gypsum board shall not be used in diaphragm ceilings to resist lateral forces imposed by masonry or concrete construction.

SECTION 2509 GYPSUM BOARD IN SHOWERS AND WATER CLOSETS

2509.1 Wet areas. Showers and public toilet walls shall conform to Sections 1210.2 and 1210.3.

2509.2 Base for tile. Cement, fiber-cement or glass mat gypsum backers in compliance with ASTM C 1178, C 1288 or C 1325 and installed in accordance with manufacturer recommendations shall be used as a base for wall tile in tub and shower areas and wall and ceiling panels in shower areas. Water-resistant gypsum backing board shall be used as a base

TABLE 2508.5
SHEAR CAPACITY FOR HORIZONTAL WOOD FRAMED GYPSUM BOARD DIAPHRAGM CEILING ASSEMBLIES

MATERIAL	THICKNESS OF MATERIAL (MINIMUM) (inches)	SPACING OF FRAMING MEMBERS (MAXIMUM) (inches)	SHEAR VALUE[a] (plf of ceiling)	MIMIMUM FASTENER SIZE
Gypsum board	$^{1}/_{2}$	16 o.c.	90	5d cooler or wallboard nail; $1^{5}/_{8}$-inch long; 0.086-inch shank; $^{15}/_{64}$ -inch head[b]
Gypsum board	$^{1}/_{2}$	24 o.c.	70	5d cooler or wallboard nail; $1^{5}/_{8}$-inch long; 0.086-inch shank; $^{15}/_{64}$ -inch head[c]

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.59 N/m.

a. Values are not cumulative with other horizontal diaphragm values and are for short-term loading due to wind loading. Values shall be reduced 25 percent for normal loading.

b. Reserved.

c. $1^{1}/_{4}$-inch, No. 6 Type S or W screws are permitted to be substituted for the listed nails.

for tile in water closet compartment walls when installed in accordance with GA-216 or ASTM C 840 and manufacturer recommendations. Regular gypsum wallboard is permitted under tile or wall panels in other wall and ceiling areas when installed in accordance with GA-216 or ASTM C 840.

2509.3 Limitations. Water-resistant gypsum backing board shall not be used in the following locations:

1. Over a vapor retarder in shower or bathtub compartments.
2. Where there will be direct exposure to water or in areas subject to continuous high humidity.
3. On ceilings where frame spacing exceeds 12 inches (305 mm) o.c. for $^1/_2$-inch-thick (12.7 mm) water-resistant gypsum backing board and more than 16 inches (406 mm) o.c. for $^5/_8$-inch-thick (15.9 mm) water-resistant gypsum backing board.

SECTION 2510 LATHING AND FURRING FOR CEMENT PLASTER (STUCCO)

2510.1 General. Exterior and interior cement plaster and lathing shall be done with the appropriate materials listed in Table 2507.2 and Chapter 35.

2510.2 Weather protection. Materials shall be stored in such a manner as to protect such materials from the weather.

2510.3 Installation. Installation of these materials shall be in compliance with ASTM C 926 and ASTM C 1063.

2510.4 Corrosion resistance. Metal lath and lath attachments shall be of corrosion-resistant material.

2510.5 Backing. Backing or a lath shall provide sufficient rigidity to permit plaster applications.

2510.5.1 Support of lath. Where lath on vertical surfaces extends between rafters or other similar projecting members, solid backing shall be installed to provide support for lath and attachments.

2510.5.2 Use of gypsum backing board.

2510.5.2.1 Use of gypsum board as a backing board. Gypsum lath or gypsum wallboard shall not be used as a backing for cement plaster.

Exception: Gypsum lath or gypsum wallboard is permitted, with a water-resistive barrier, as a backing for self-furred metal lath or self-furred wire fabric lath and cement plaster where either of the following conditions occur:

1. On horizontal supports of ceilings or roof soffits.
2. On interior walls.

2510.5.2.2 Use of gypsum sheathing backing. Gypsum sheathing is permitted as a backing for metal or wire fabric lath and cement plaster on walls. A water-resistive barrier shall be provided in accordance with Section 2510.6.

2510.5.3 Backing not required. Wire backing is not required under expanded metal lath or paperbacked wire fabric lath.

2510.6 Water-resistive barriers. Water-resistive barriers shall be installed as required in Section 1404.2 and, where applied over wood-based sheathing, shall include a water-resistive vapor-permeable barrier with a performance at least equivalent to two layers of Grade D paper.

Exception: Where the water-resistive barrier that is applied over wood-based sheathing has a water resistance equal to or greater than that of 60-minute Grade D paper and is separated from the stucco by an intervening, substantially nonwater-absorbing layer or drainage space.

2510.7 Preparation of masonry and concrete. Surfaces shall be clean, free from efflorescence, sufficiently damp and rough for proper bond. If the surface is insufficiently rough, approved bonding agents or a portland cement dash bond coat mixed in proportions of not more than two parts volume of sand to one part volume of portland cement or plastic cement shall be applied. The dash bond coat shall be left undisturbed and shall be moist cured not less than 24 hours.

2510.8 Fenestration. The juncture of exterior plaster and fenestration products shall be sealed with a sealant complying with AAMA 800 and ASTM C 920 Class 25 Grade NS or greater for proper joint expansion and contraction, ASTM C 1281, AAMA 812, or other approved standard as appropriate for the type of sealant.

SECTION 2511 INTERIOR PLASTER

2511.1 General. Plastering gypsum plaster or cement plaster shall not be less than three coats where applied over metal lath or wire fabric lath and not less than two coats where applied over other bases permitted by this chapter.

Exception: Gypsum veneer plaster and cement plaster specifically designed and approved for one-coat applications.

2511.1.1 Installation. Installation of lathing and plaster materials shall conform with Table 2511.1.1 and Section 2507.

TABLE 2511.1.1 INSTALLATION OF PLASTER CONSTRUCTION

MATERIAL	STANDARD
Gypsum plaster	ASTM C 842
Gypsum veneer plaster	ASTM C 843
Interior lathing and furring (gypsum plaster)	ASTM C 841
Lathing and furring (cement plaster)	ASTM C 1063
Portland cement plaster	ASTM C 926
Steel framing	ASTM C 754; C 1007

2511.2 Limitations. Plaster shall not be applied directly to fiber insulation board. Cement plaster shall not be applied directly to gypsum lath or gypsum plaster except as specified in Sections 2510.5.1 and 2510.5.2.

2511.3 Grounds. Where installed, grounds shall ensure the minimum thickness of plaster as set forth in ASTM C 842 and ASTM C 926. Plaster thickness shall be measured from the face of lath and other bases.

2511.4 Interior masonry or concrete. Condition of surfaces shall be as specified in Section 2510.7. Approved specially prepared gypsum plaster designed for application to concrete surfaces or approved acoustical plaster is permitted. The total thickness of base coat plaster applied to concrete ceilings shall be as set forth in ASTM C 842 or ASTM C 926. Should ceiling surfaces require more than the maximum thickness permitted in ASTM C 842 or ASTM C 926, metal lath or wire fabric lath shall be installed on such surfaces before plastering.

2511.5 Wet areas. Showers and public toilet walls shall conform to Sections 1210.2 and 1210.3. When wood frame walls and partitions are covered on the interior with cement plaster or tile of similar material and are subject to water splash, the framing shall be protected with an approved moisture barrier.

SECTION 2512
EXTERIOR PLASTER

2512.1 General. Plastering with cement plaster shall not be less than three coats where applied over metal lath or wire fabric lath and not less than two coats where applied over masonry, concrete or gypsum board backing as specified in Section 2510.5. If the plaster surface is to be completely covered by veneer or other facing material, or is completely concealed by another wall, plaster application need be only two coats, provided the total thickness is as set forth in ASTM C 926.

2512.1.1 On-grade floor slab. On wood framed or steel stud construction with an on-grade concrete floor slab system, exterior plaster shall be applied in such a manner as to cover, but not to extend below, the lath and paper. The application of lath, paper and flashing or drip screeds shall comply with ASTM C 1063.

2512.1.2 Weep screeds. A minimum 0.019-inch (0.48 mm) (No. 26 galvanized sheet gage), corrosion-resistant weep screed with a minimum vertical attachment flange of $3^1/_2$ inches (89 mm) shall be provided at or below the foundation plate line on exterior stud walls in accordance with ASTM C 926. The weep screed shall be placed a minimum of 4 inches (102 mm) above the earth or 2 inches (51 mm) above paved areas and be of a type that will allow trapped water to drain to the exterior of the building. The water-resistive barrier shall lap the attachment flange. The exterior lath shall cover and terminate on the attachment flange of the weep screed.

2512.2 Plasticity agents. Only approved plasticity agents and approved amounts thereof shall be added to portland cement. When plastic cement or masonry cement is used, no additional lime or plasticizers shall be added. Hydrated lime or the equivalent amount of lime putty used as a plasticizer is permitted to be added to cement plaster or cement and lime plaster in an amount not to exceed that set forth in ASTM C 926.

2512.3 Limitations. Gypsum plaster shall not be used on exterior surfaces.

2512.4 Cement plaster. Plaster coats shall be protected from freezing for a period of not less than 24 hours after set has occurred. Plaster shall be applied when the ambient temperature is higher than 40°F (4°C), unless provisions are made to keep cement plaster work above 40°F (4°C) during application and 48 hours thereafter.

2512.5 Second-coat application. The second coat shall be brought out to proper thickness, rodded and floated sufficiently rough to provide adequate bond for the finish coat. The second coat shall have no variation greater than $^1/_4$ inch (6.4 mm) in any direction under a 5-foot (1524 mm) straight edge.

2512.6 Curing and interval. First and second coats of cement plaster shall be applied and moist cured as set forth in ASTM C 926 and Table 2512.6.

TABLE 2512.6
CEMENT PLASTERS[a]

COAT	MINIMUM PERIOD MOIST CURING	MINIMUM INTERVAL BETWEEN COATS
First	48 hours[a]	48 hours[b]
Second	48 hours	7 days[c]
Finish	—	Note c

a. The first two coats shall be as required for the first coats of exterior plaster, except that the moist-curing time period between the first and second coats shall not be less than 24 hours. Moist curing shall not be required where job and weather conditions are favorable to the retention of moisture in the cement plaster for the required time period.

b. Twenty-four-hour minimum interval between coats of interior cement plaster. For alternate method of application, see Section 2512.8.

c. Finish coat plaster is permitted to be applied to interior portland cement base coats after a 48-hour period.

2512.7 Application to solid backings. Where applied over gypsum backing as specified in Section 2510.5 or directly to unit masonry surfaces, the second coat is permitted to be applied as soon as the first coat has attained sufficient hardness.

2512.8 Alternate method of application. The second coat is permitted to be applied as soon as the first coat has attained sufficiently rigidity to receive the second coat.

2512.8.1 Admixtures. When using this method of application, calcium aluminate cement up to 15 percent of the weight of the portland cement is permitted to be added to the mix.

2512.8.2 Curing. Curing of the first coat is permitted to be omitted and the second coat shall be cured as set forth in ASTM C 926 and Table 2512.6.

2512.9 Finish coats. Cement plaster finish coats shall be applied over base coats that have been in place for the time periods set forth in ASTM C 926. The third or finish coat shall be applied with sufficient material and pressure to bond and to cover the brown coat and shall be of sufficient thickness to conceal the brown coat.

SECTION 2513
EXPOSED AGGREGATE PLASTER

2513.1 General. Exposed natural or integrally colored aggregate is permitted to be partially embedded in a natural or colored bedding coat of cement plaster or gypsum plaster, subject to the provisions of this section.

2513.2 Aggregate. The aggregate shall be applied manually or mechanically and shall consist of marble chips, pebbles or similar durable, moderately hard (three or more on the Mohs hardness scale), nonreactive materials.

2513.3 Bedding coat proportions. The bedding coat for interior or exterior surfaces shall be composed of one-part portland cement, one-part Type S lime and a maximum of three parts of graded white or natural sand by volume. The bedding coat for interior surfaces shall be composed of 100 pounds (45.4 kg) of neat gypsum plaster and a maximum of 200 pounds (90.8 kg) of graded white sand. A factory-prepared bedding coat for interior or exterior use is permitted. The bedding coat for exterior surfaces shall have a minimum compressive strength of 1,000 pounds per square inch (psi) (6895 kPa).

2513.4 Application. The bedding coat is permitted to be applied directly over the first (scratch) coat of plaster, provided the ultimate overall thickness is a minimum of $^7/_8$ inch (22 mm), including lath. Over concrete or masonry surfaces, the overall thickness shall be a minimum of $^1/_2$ inch (12.7 mm).

2513.5 Bases. Exposed aggregate plaster is permitted to be applied over concrete, masonry, cement plaster base coats or gypsum plaster base coats installed in accordance with Section 2511 or 2512.

2513.6 Preparation of masonry and concrete. Masonry and concrete surfaces shall be prepared in accordance with the provisions of Section 2510.7.

2513.7 Curing of base coats. Cement plaster base coats shall be cured in accordance with ASTM C 926. Cement plaster bedding coats shall retain sufficient moisture for hydration (hardening) for 24 hours minimum or, where necessary, shall be kept damp for 24 hours by light water spraying.

SECTION 2514
HIGH-VELOCITY HURRICANE ZONES — LATHING

2514.1 General. Lath shall be gypsum, metal or wire lath, as set forth herein, and shall conform to the *Standard Specification for Interior Lathing and Furring*, ANSI A42.4.

2514.2 Gypsum lath. Gypsum lath shall conform to the *Standard Specification for Gypsum Lath*, ASTM C37.

2514.2.1 Gypsum lath shall be nailed to wood supports, at intervals not to exceed 5 inches (127 mm), with 13-gauge galvanized or blued nails having $^{19}/_{64}$-inch (7.5 mm) diameter flat heads (7.5 mm). Nails shall be not less than $1^1/_8$-inches (29 mm) long for $^3/_8$-inch(9.5 mm) lath nor less than $1^1/_4$-inches (32 mm) for $^1/_2$-inch (12.7 mm) lath. Each 16-inch (406 mm) width of lath shall be secured to each support with not less than five nails except that where fire-resistive-rated construction is not required, there shall not be less than four nails.

2514.2.2 Lath shall be secured to horizontal or vertical metal supports by means of approved special clips.

2514.2.3 The center-to-center spacing of wood supports shall not exceed 16 inches (406 mm) for $^3/_8$-inch (9.5 mm) gypsum lath and shall not exceed 24 inches (610 mm) for $^1/_2$-inch (12.7 mm) gypsum lath.

2514.2.4 The center-to-center spacing for gypsum lath applied to metal studs shall not exceed that set forth herein above for wood supports except that $^3/_8$-inch (9.5 mm) gypsum lath may be applied to metal studs spaced 24 inches (610 mm) on centers where a minimum of $^3/_4$-inch (19 mm), three-coat plaster is applied over the lath.

2514.2.5 Lath shall be applied with face side out and with the long dimension at right angles to the framing members. Joints shall be broken in each course, except that end joints may fall on one support when such joints are covered with 3 inch (76 mm) wide strips of metal lath. Lath shall be butted together.

2514.2.6 Corner bead and inside angle reinforcing shall not be required.

2514.2.7 No interior lath shall be applied until the roof is on and the building is dried in.

2514.3 Metal and wire lath.

2514.3.1 Metal and wire lath and metal accessories embedded in the plaster shall be galvanized or otherwise rust-resistant by approved means. Weight tags shall be left on all metal or wire lath until approved by the building official.

2514.3.2 The weight of metal and wire lath and the spacing of supports shall conform to the requirements set forth in Table 2514.3.2.

2514.3.3 All metal lath shall be lapped 1 inch (25 mm) minimum.

2514.3.4 All attachments for securing metal lath, wire lath and wire fabric to supports shall be spaced not more than 6 inches (152 mm) apart, and side laps shall be secured to supports and be tied between supports at not to exceed 9 inches (229 mm) intervals.

2514.3.5 Metal and wire lath shall be attached to vertical wood supports with the equivalent of 4d galvanized or blue common nails driven to a penetration of at least $^3/_4$ inch (19 mm) and bent over to engage not less than three strands of lath. Metal and wire lath shall be attached to ceiling joists or other horizontal wood supports with the equivalent of No. 11-gauge, barbed, galvanized or blued nails $1^1/_2$ inches (38 mm) long having a head not less than $^3/_8$ inch (9.5 mm) in diameter.

2514.3.6 Metal and wire lath shall be attached to horizontal and vertical metal supports with the equivalent of No. 8 galvanized sheet-metal screws.

2514.4 Nonbearing lath and plaster partitions.

2514.4.1 Where reinforced plaster or pneumatically placed plaster partitions are used, they shall have vertical steel or iron channels with a depth of not less than one-third of the thickness of the partition and spaced not more than 24 inches (610 mm) on centers. The thickness of metal in the channels shall not be less than 16 U.S. standard gauge or light gauge steel studs.

TABLE 2514.3.2
WEIGHTS OF METAL AND WIRE LATH(*)

TYPE OF LATH	MINIMUM WGT (lb per sq yd)	MAXIMUM SPACING OF SUPPORTS (in.)	
		For Walls	For Ceilings
Flat Expanded Metal Lath	2.5	16	0
Flat Expanded Metal Lath	3.4	16	16
Flat Rib Metal Lath	2.75	16	12
Flat Rib Metal Lath	3.4	19	19
$^3/_8$" Rib Metal Lath	3.4	24	24
Sheet-Metal Lath	4.5	24	24
Wire Lath	2.48	16	12
Wire Fabric	**	16	16

For SI: 1 inch = 25.4 mm, 1 square yard = 0.8361 m^2.
* V-stiffened that expanded metal lath of equal rigidity and weight is permissible on the same spacings as $^3/_8$-inch rib metal lath.
** Paper-backed wire fabric, No. 16-gauge wire, 2-inch by 2-inch mesh, with stiffener.

2514.4.2 Hollow nonbearing partitions of reinforced plaster or pneumatically placed plaster shall have a shell thickness of not less than $^3/_4$ inch (19 mm).

2514.4.3 Metal reinforcing shall be as set forth in Table 2514.3.2, and gypsum lath shall not be less than $^3/_8$ inch (9.5 mm) in thickness. The minimum thickness of metal lath and plaster partitions shall be not less than 2 inches (51 mm) or $^1/_{84}$ of the distance between supports.

2514.5 Suspended and furred plaster ceilings.

2514.5.1 General. Suspended or furred plaster ceilings shall be designed and constructed as set forth herein.

2514.5.2 Main runners. Main runners or carriers shall be rolled steel channels not less than the sizes and weights set forth in Table 2514.5.2.

A main runner shall be located not more than 6 inches (152 mm) from parallel walls to support the ends of cross furring. The ends of main runners at walls shall be supported by hangers located not more than 12 inches (305 mm) from such ends. Splices in main runners shall be lapped 12 inches (305 mm) and tied, each end, with double loops of No. 16-gauge wire.

2514.5.3 Cross furring. Cross furring, or spacers, for various spacing of main runners or other supports shall be not less than as set forth in Table 2514.5.3.

2514.5.3.1 Cross furring shall be securely saddle-tied to the main runners by not less than two strands of No. 16 W and M gauge galvanized wire or equivalent approved attachments. Cross furring shall be attached to joists or beams with double No. 14 W and M gauge galvanized wire or equivalent approved attachments.

Splices in cross furring shall be lapped 8 inches (203 mm) and tied, each end, with double loops of No. 16-gauge wire.

2514.5.4 Hangers. Hangers supporting suspended ceilings shall be not less than as set forth in Table 2514.5.4.

TABLE 2514.5.2
SPANS AND SPACING OF MAIN RUNNERS

MINIMUM SIZE AND TYPE (inches)	MAXIMUM SPAN BETWEEN HANGERS OR SUPPORTS (feet, inches)	MAXIMUM CENTER-TO-CENTER SPACING OF RUNNERS (feet, inches)
$^3/_4$ - 0.3 lb per ft	2-0	3-0
1-$^1/_2$ - 0.475 lb per ft	3-0	4-0
1-$^1/_2$ - 0.475 lb per ft	3-6	3-6
1-$^1/_2$ - 0.475 lb per ft	4-0	3-0
1-$^1/_2$ - 1.12 lb per ft	4-0	5-0
2 -1.26 lb per ft	5-0	5-0
1-$^1/_2$ x 1-$^1/_2${*} by $^3/_{16}$ angle	5-0	5-0

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 lb/ft = 1.4882 kg/m.

TABLE 2514.5.3
SIZES OF CROSS FURRING IN SUSPENDED AND FURRED CEILINGS

SIZE AND TYPE (inches)	MAXIMUM SPAN BETWEEN SUPPORTS (feet)	MAXIMUM SPACING (inches)
$^1/_4$ pencil rods	Up to 2-0	12
$^3/_4$ channels	Up to 3-0	24
$^3/_4$ channels	Up to 4-0	16

For SI: 1 inch = 25.4 mm.

TABLE 2514.5.4
HANGERS SUPPORTING SUSPENDED CEILINGS

CEILING AREA SUPPORTED (SQUARE FEET)	MINIMUM SIZE OF HANGER
12.5	8-gauge wire
16	6-gauge wire
18	$^3/_{16}$" rod
22.5	$^1/_4$" rod
50	1" x $^3/_{16}$" flat bar

For SI: 1 inch = 25.4 mm.

2514.5.4.1 Hangers shall be saddle-tied or wrapped around main runners to develop the full strength of the hangers. Hangers shall be fastened to or embedded in the structural framing, masonry or concrete. Lower ends of flat-strap hangers shall be bolted with $^3/_8$ inch (9.5 mm) bolts to runner channels or bent tightly around corners and bolted to the main part of the hanger. Where the area of a plastered ceiling exceeds 100 square feet (93 m^2), suitable methods to resist uplift forces shall be provided for each 64 square feet (6 m^2) of ceiling.

SECTION 2515
HIGH-VELOCITY HURRICANE ZONES — PLASTER

2515.1 General.

2515.1.1 Gypsum plastering shall conform to the *Standard Specification for Gypsum Plastering*, ANSI A42.1.

2515.1.2 Plastering with gypsum, hardwall, lime or cement plaster shall be three-coat work when applied over metal and wire lath and shall be not less than two-coat work when applied over gypsum lath or gypsum block.

2515.1.3 Portland cement plaster shall not be applied directly to gypsum lath.

2515.1.4 In no case shall a brush coat be accepted as a required coat where three-coat work is required by this section.

2515.1.5 Grounds shall be installed to provide for the thickness of plaster, as set forth in Table 2515.1.5, as measured from the face of the lath.

TABLE 2515.1.5
REQUIRED THICKNESS OF INTERIOR PLASTER

TYPE OF LATH	THICKNESS OF PLASTER (inches)
Metal or wire lath	$^5/_8$ minimum
Gypsum lath	$^1/_2$ minimum

For SI: 1 inch = 25.4 mm.

2515.1.6 If monolithic-concrete ceiling surfaces require more than $^3/_8$ inch (9.5 mm) of plaster to produce desired lines or surfaces, metal lath or wire lath shall be attached thereto; except that special bonding agents approved by the building official may be used.

2515.1.7 The building official may require test holes to be made for the purpose of determining the thickness of plaster.

2515.2 Materials.

2515.2.1 Aggregates.

2515.2.1.1 Inorganic aggregates used for plaster and stucco shall conform to the *Standard Specification for Inorganic Aggregates for Use In Gypsum Plaster*, ASTM C 35, except that graduation of locally produced sand shall be such that the fineness modulus is between 1.20 and 2.35.

2515.2.1.2 Aggregates shall be quarried or washed in fresh water and shall contain not more than 1/20 of one percent salt, by weight.

2515.2.2 Gypsum. Gypsum plaster shall conform to the *Standard Specification for Gypsum Plaster*, ASTM C 28.

2515.2.3 Lime. Lime shall conform to the *Standard Specification for Quicklime for Structural Purposes*, ASTM C 5, and the *Standard Specification for Special Finish Hydrated Lime*, ASTM C 206.

2515.2.4 Keene's cement. Keene's cement shall conform to the *Standard Specification for Keene's Cement*, ASTM C 61.

2515.2.5 Portland cement.

2515.2.5.1 Portland cement shall conform to the *Standard Specification for Portland Cement*, ASTM C 150.

2515.2.5.2 Approved types of plasticity agents may be added to cement in the manufacturing process or when mixing the plaster, but in no case shall the amount of the

TABLE 2515.3.1.1
GYPSUM AND HARDWALL PLASTER

APPLICATION METHOD	DAMP LOOSE SAND (LB)	VERMICULITE OR PERLITE (CU FT)
TWO-COAT WORK (DOUBLE-UP METHOD)		
(1) Over gypsum lath	250	2-1/2
(2) Over masonry[2]	300	3
THREE-COAT WORK		
(1) First (scratch) coat over lath	200[1]	2
(2) First (scratch) coat over masonry	300	3
(3) All second (brown) coats	300[1]	3

For SI: 1 cubic foot = 0.02832 m^3, 1 pound = 0.454 kg.

1. Except over monolithic concrete.
2. In lieu of the proportioning specified, the proportions may be 100 pounds of gypsum neat plaster to not more than 250 pounds of damp, loose sand or $2^1/_2$ cubic feet of vermiculite or perlite, provided this proportioning is used for both scratch and brown coats.

plasticity agent exceed 10 percent of the volume of cement in the plaster mixture.

2515.2.6 Masonry cement. Masonry cement shall be Type II and shall conform to the *Standard Specification for Masonry Cement*, ASTM C 91.

2515.3 Proportioning and mixing.

2515.3.1 Base coats. The proportions of sand, vermiculite or perlite to 100 pounds (45.4 kg) of gypsum neat plaster shall not exceed the requirements in this section.

2515.3.1.1 Gypsum or hardwall plaster. Gypsum or hardwall plaster shall be proportioned in accordance with Section 2515.3.1.1.

2515.3.1.2 Wood-fiber gypsum plaster. Wood-fiber gypsum plaster for use on all types of lath shall be mixed with water only and shall be mixed in the proportion of one part of plaster to one part of sand, by weight, for use on masonry.

2515.3.1.3 Ready mixed plaster. Gypsum ready-mixed plaster shall be in the proportion of 100 pounds (45.4 kg) of gypsum neat plaster to not more than 250 pounds (113 kg) of sand; or when vermiculite or perlite is used as an aggregate, the proportions shall be 100 pounds (45.4 kg) of gypsum neat plaster to not more than $2^1/_2$ cubic feet (0.07 m^3) vermiculite or perlite.

2515.3.1.4 Portland cement plaster. For three-coat work, the first two coats shall be required for the first two coats of exterior stucco (see Section 2516).

2515.3.1.5 Masonry cement plaster. For two- or three-coat work, all work shall be set forth in Section 2515.

2515.3.2 Finish coats for gypsum or lime plaster. The finish coats shall be mixed and proportioned in accordance with this section.

2515.3.2.1 Smooth white finish, mixed in the proportion of not less than one part gypsum gaging plaster to three parts lime putty, by volume, or an approved prepared gypsum trowel finish.

2515.3.2.2 Sand-float finish, mixed in the proportion of one-half part of Keene's cement to two parts of lime putty and not more than four and one-half parts of sand, by volume, or an approved gypsum sand-float finish.

2515.3.2.3 Keene's cement finish, mixed in the proportion of three parts Keene's cement to one part lime putty, by volume.

2515.3.2.4 Lime sand-float finish, mixed in the proportion of three parts lime putty to three parts sand, by volume.

2515.3.2.5 Finish coat for perlite or vermiculite aggregate plasters, mixed in the proportion of 1 cubic foot (28 339 cc) of aggregate to 100 pound (45 kg) of unfibered gypsum plaster, or mixed according to manufacturer's specifications.

2515.3.3 Finish coat for Portland cement plaster. Finish coats for interior Portland cement plaster shall be one of the following:

1. As required for the third coat of exterior stucco. See Section 2413.
2. A gaged cement plaster mixed in proportion of one part Portland cement to not more than 15 percent lime putty and not more than four parts of sand, by volume.

2515.3.4 Finish coat for masonry cement plaster. Finish coat for masonry cement plaster shall be as set forth in Section 2515.4.2.3.

2515.4 Application.

2515.4.1 Base coats.

2515.4.1.1 Gypsum plaster. The scratch coat shall be applied with sufficient material and pressure to form a full key or bond.

2515.4.1.1.1 For two-coat work it shall be doubled back to bring the plaster out to grounds and straightened to a true surface and left rough to receive the finish coat.

2515.4.1.1.2 For three-coat work, the scratch (first) coat shall be scratched to a rough surface. The brown (second) coat shall be applied after the scratch coat has set firm and hard, brought out to grounds, straightened to a true surface with rod and darby and left rough, ready to receive the finish (third) coat.

2515.4.1.1.3 The finish coat shall be applied to a practically dry base coat or to a thoroughly dry base coat which has been evenly wetted by brushing or spraying. The use of excessive water shall be avoided in the application of all types of finish coat plastering.

2515.4.1.2 Portland cement plaster. The first two coats shall be as required for the first two coats of exterior stucco, except that the interval between the first and second coats shall be not less than 24 hours.

2515.4.1.3 Masonry cement plaster. Where masonry cement is the only cementitious material, the second coat may be applied to the base coat as soon as the base coat has attained sufficient strength and rigidity to support the second (finish) coat.

2515.4.2 Finish.

2515.4.2.1 Smooth white finish shall be applied over the base coat that has set for a period of not less than 24 hours and is surface dry. Thickness shall be from $^{1}/_{16}$ inch to $^{1}/_{8}$ inch (1.6 mm to 3.3 mm).

2515.4.2.2 Sand-float finish shall be applied over the set base coat that is not quite dry.

2515.4.2.3 Keene's cement finish shall be applied over the set base coat that is not quite dry. Thickness shall be from $^{1}/_{16}$ inch to $^{1}/_{8}$ inch (1.6 to 3.3 mm), unless finish coat is marked off or is jointed; in which case, the thickness may be increased as required by depth of marking or jointing.

2515.4.2.4 The finish coat for interior Portland cement plastering shall be applied in the same manner as required for the third coat of exterior stucco, except that other types of finish coat may be applied as specified in Section 2413.

2515.4.2.5 The finish coat for lightweight aggregate plastering shall be from $^{1}/_{16}$ inch to $^{1}/_{8}$ inch (1.6 mm to 3.3 mm).

2515.4.3 Plaster on concrete.

2515.4.3.1 Monolithic concrete surfaces shall be clean, free from efflorescence, damp and sufficiently rough to insure adequate bond.

2515.4.3.2 Gypsum plaster applied to monolithic-concrete ceilings shall be specially prepared bond plaster for use on concrete, to which only water shall be added. Gypsum plaster on monolithic walls and columns shall be applied over a scratch coat of bond plaster, or other bonding material, before it has set. The brown coat shall be brought out to grounds, straightened to a true surface and left rough, ready to receive the finish coat.

2515.4.3.3 Portland cement plaster applied to interior concrete walls or ceilings shall conform to requirements for application to exterior concrete walls as specified in Section 2516.

SECTION 2516
HIGH-VELOCITY HURRICANE ZONES — STUCCO

2516.1 General.

2516.1.1 Portland cement-based plaster shall be applied in accordance with ASTM C 926, excluding Table 4 of that standard.

2516.1.2 Stucco base and finish coats, where required to meet fire-resistance requirements, shall be mixed in proportion of at least one part portland cement to a maximum of two and one-half parts sand by volume.

2516.1.3 Approved manufacturing products may be used for base and finish coats.

2516.1.4 Materials. The materials of stucco shall conform to ASTM C 926.

2516.1.5 Admixtures.

2516.1.5.1 Plasticity agents shall be of approved types and amounts and, where added to Portland cement in the manufacturing process, no additions shall be made later.

2516.1.5.2 Color may be added to the finish coat in approved amounts.

2516.1.6 Application.

2516.1.6.1 Stucco applied to concrete or masonry to meet fire-resistance requirements shall consist of at least two coats, and the total thickness shall be not less than $^{1}/_{2}$ inch (12.7 mm).

2516.1.6.2 Masonry surfaces on which all stucco is applied shall be clean, free from efflorescence, damp and sufficiently rough, or coated with an approved bonding agent, to insure proper bond.

2516.1.6.3 All concrete surfaces shall be coated with an approved bonding agent or shall be effectively roughened.

2516.1.6.4 The first coat shall be well forced into the pores of the masonry, shall be brought out to grounds, straightened to a true surface and left rough enough to receive the finish coat.

2516.1.6.5 The first coat shall be rodded and waterfloated to a true surface approximately one-half the total thickness.

2516.1.6.6 The base coat shall be damp cured for a period of not less than 24 hours.

2516.1.6.7 In lieu thereof, the finish coat, where containing appropriate waterproofing or curing admixtures, may be applied as soon as the base coat has attained initial set and is sufficiently firm to receive the finish coat.

2516.1.6.8 The finish coat shall be applied over a uniformly damp but surface-dry base.

2516.1.6.9 Stucco shall be kept damp for a period of not less than 48 hours after application of the finish coat.

2516.1.6.10 In lieu thereof, the finish coat may contain appropriate approved waterproofing or curing agents.

2516.2 Stucco on walls other than concrete or masonry.

2516.2.1 General. Stucco shall be as set forth in Section 2516.1.

2516.2.2 Moisture barrier. Wood shall be covered with 15-pound (7 kg) roofing felt, or other approved equally moisture-resisting layer, and metal reinforcement as set forth herein.

2516.2.3 Metal reinforcement.

2516.2.3.1 Stucco shall be reinforced with galvanized expanded metal weighing no less than 1.8 pounds per square yard (0.98 kg/m^2), or galvanized welded or woven wire-fabric weighing no less than 1 pound per square yard (0.54 kg/m^2).

2516.2.3.2 All metal lathing shall be lapped not less than 1 inch (25 mm).

2516.2.3.3 Metal reinforcement shall be furred out from the backing by an approved method.

2516.2.3.4 Fastenings into wood sheathing or wood framing shall be by galvanized nails, with heads not less than $^3/_8$ inch (9.5 mm) in diameter, driven to full penetration, using a minimum of two nails per square foot (0.093 m^2), or by approved staples having equal resistance to withdrawal.

2516.2.3.5 The fastening of rib-lath to metal members shall be by #8 galvanized sheet-metal screws, using a minimum of two screws per square foot (0.093 m^2).

2516.2.4 Application.

2516.2.4.1 Stucco applied on metal lath shall be three-coat work applied to a total thickness of not less than $^1/_2$ inch (12.7 mm) thickness except as required to meet fire-resistance requirements.

2516.2.4.2 The first coat shall be forced through all openings in the reinforcement to fill all spaces and scored horizontally.

2516.2.4.3 The second coat shall be applied after the first coat has set sufficiently to provide a rigid backing.

2516.2.4.4 The third coat shall be applied as soon as the second coat has attained initial set.

2516.3 Pneumatically placed stucco.

2516.3.1 Pneumatically-placed stucco shall consist of a mixture of one part Portland cement to not more than five parts sand, conveyed through a pipe or flexible tube and deposited by pressure in its final position.

2516.3.2 Rebound material may be screened and reused as sand in an amount not greater than 25 percent of the total sand in any batch.

2516.3.3 Plasticity agents may be used as specified in Section 2516.1.5.1.

SECTION 2517
HIGH-VELOCITY HURRICANE ZONES — GYPSUM BOARD PRODUCTS AND ACCESSORY ITEMS

2517.1 General.

2517.1.1 Gypsum wallboard products and related items and accessories to be used with or without the addition of plaster for partitions, walls and ceilings shall be as set forth in this section.

2517.1.2 Where required to be fire resistive, such assemblies shall also comply with Chapter 7 of this code.

2517.2 Standards. The following standards are adopted as set forth in Chapter 35.

Standard Specification for the Application and Finishing of Gypsum Wallboard, ANSI A97.1.

Specification for Gypsum Wallboard, ASTM C 36.

Specification for General Requirements for Zinc-Coated (Galvanized) Steel Sheets, by the Hot-Dip Process, ASTM A 525.

Specification for Light-gauge Steel Studs, Runners, and Rigid Furring Channels, ASTM C 645.

Specification for Joint Treatment Materials for Gypsum Wallboard Construction, ASTM C 475.

2517.3 Gypsum wallboard.

2517.3.1 The gypsum wallboard shall comply with the standards set forth in Section 2517.2, and single or multiple system combinations shall be not less than $^1/_2$ inch (12.7 mm) in thickness.

2517.3.2 The span between supports for gypsum wallboard shall be not more than 24 inches (610 mm) for $^1/_2$ inch (12.7 mm) thick and $^5/_8$ inch (17.1 mm) thick wallboard.

2517.3.3 Gypsum wallboard used in fire-rated assemblies shall be of a type for which test ratings are available.

2517.4 Wood studs and wood ceiling supports. Wood studs and wood ceiling supports shall comply with Chapter 23 (High-Velocity Hurricane Zones).

2517.5 Steel studs, ceiling supports and track runners.

2517.5.1 Steel studs and runners used to construct fire-resistive walls or partitions shall be hot-dipped galvanized in accordance with ASTM A 525, coating designation G40, minimum and be of channel or "C"-type shape. The total thickness of the base metal plus coating shall not be less than 0.0184 inch (0.467 mm) unpainted and not less than 0.0194 inch (0.493 mm) if coated and painted. Studs and runners shall comply with ASTM C 645 and have a base metal thickness, before application of any coating, of not less than 0.0179 inch (0.455 mm). Structural properties of such studs and runners shall comply with ASTM C 645.

2517.5.1.1 Steel studs supporting wall hung plumbing fixtures shall be doubled or not less than 20 gauge with a minimum effective moment of inertia equal to 0.864 in.^{4} (360 m^4).

2517.5.1.2 Such studs shall be rigidly connected top and bottom to prevent significant end rotation or displacement.

2517.5.1.3 A horizontal member securely fastened to not less than two studs shall be installed for the attachment of each wall hung plumbing fixture.

2517.5.2 The unsupported height of partitions shall comply with the loads and deflections set forth in Chapter 16 (High-Velocity Hurricane Zones) and where wallboard is suitably attached, the composite action may be accounted for in the design.

2517.5.3 Steel ceiling supports shall comply with Section 2514.5.

2517.5.4 Steel studs track runners and ceiling supports in walls, including curtain walls, shall comply with ASTM A 525.

Exception: Such members in interior nonload-bearing walls need not be galvanized but shall comply with ASTM C 645.

2517.6 Attachments.

2517.6.1 Attachments shall be as set forth herein and for fire-rated assemblies shall also conform to the material and conditions of the assembly tested.

2517.6.2 Attachment to wood supporting members shall conform to the standard set forth in Section 2517.2.

2517.6.3 Nails and screws attaching gypsum wallboard shall, without substantially fracturing the surface paper, be driven below the surface and spotted with finishing joint compound.

2517.6.4 Attachment to metal members shall be in accordance with Section 2517.6.4.1 through Section 2517.6.4.5.

2517.6.4.1 Gypsum wallboard shall be attached to metal members by self-drilling, self-tapping sheet metal screws.

2517.6.4.2 The spacing of screws attaching gypsum wallboard to metal studs and runners, shall be not more than 12 inches (305 mm) on center.

2517.6.4.3 Screws for attaching gypsum wallboard to metal studs shall be not less than $^7/_8$ inch (22.2 mm) long for $^1/_2$ inch (17.7 mm) wallboard or 1 inch (25.4 mm) long for $^5/_8$ inch (17.1 mm) wallboard.

2517.6.4.4 Screws attaching gypsum wallboard shall be driven below the surface and spotted with finishing compound.

2517.6.4.5 Runners shall be fastened to the ceiling, contiguous walls and partitions and to the floor at intervals not exceeding 24 inches (610 mm) on center. Such attachment may be by nails penetrating the base material not less than $^5/_8$ inch (17.1 mm) or by self-drilling, self-tapping sheet metal screws attaching metal to metal.

SECTION 2518
HIGH-VELOCITY HURRICANE ZONES — SUSPENDED AND FURRED CEILINGS

2518.1 General. Lath and plaster ceilings shall be as set forth in this chapter.

2518.2 Suspended and furred ceilings, other than lath and plaster where providing fire protection shall comply with Chapter 7.

2518.3 Suspended and furred ceilings, other than lath and plaster, shall be suspended and supported in conformance with the conditions of fire tests or, if not tested, as recommended by the manufacturer or as required for structural stability.

SECTION 2519
HIGH-VELOCITY HURRICANE ZONES — ASBESTOS

2519.1 Asbestos cement shall not be permitted for use under this code.

SECTION 2520
HIGH-VELOCITY HURRICANE ZONES — TILE

2520.1 Ceramic and Portland cement floor tile shall be set on a concrete slab or on wood sheathing on wood joists protected by a waterproof membrane.

2520.2 Floor tile shall be set in a mortar bed of one part portland cement to three parts aggregate or otherwise bedded in an approved adhesive material.

2520.2.1 Ceramic and portland cement wall tile used in areas subject to frequent wearing shall be backed with masonry, stucco on wire lath or approved tile backer board.

2520.2.2 Wall tile used in areas not subject to frequent wearing shall be backed by a cladding having the rigidity of stucco on wire lath and shall be bedded in cement mortar or other approved adhesive material.

2520.3 Portland cement or other porous tile shall be soaked in water not less than 1 hour before placing.

2520.4 Built-in tubs with overhead showers shall have waterproof joints between the tub and the wall and floor.

CHAPTER 26
PLASTIC

SECTION 2601
GENERAL

2601.1 Scope. These provisions shall govern the materials, design, application, construction and installation of foam plastic, foam plastic insulation, plastic veneer, interior plastic finish and trim and light-transmitting plastics. See Chapter 14 for requirements for exterior wall finish and trim.

> **Exception:** Buildings and structures located within the high-velocity hurricane zone shall comply with the provisions of Sections 2603.9 and 2612.

SECTION 2602
DEFINITIONS

2602.1 General. The following words and terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meanings shown herein.

FOAM PLASTIC INSULATION. A plastic that is intentionally expanded by the use of a foaming agent to produce a reduced-density plastic containing voids consisting of open or closed cells distributed throughout the plastic for thermal insulating or acoustical purposes and that has a density less than 20 pounds per cubic foot (pcf) (320 kg/m^3).

LIGHT-DIFFUSING SYSTEM. Construction consisting in whole or in part of lenses, panels, grids or baffles made with light-transmitting plastics positioned below independently mounted electrical light sources, skylights or light-transmitting plastic roof panels. Lenses, panels, grids and baffles that are part of an electrical fixture shall not be considered as a light-diffusing system.

LIGHT-TRANSMITTING PLASTIC ROOF PANELS. Structural plastic panels other than skylights that are fastened to structural members, or panels or sheathing and that are used as light-transmitting media in the plane of the roof.

LIGHT-TRANSMITTING PLASTIC WALL PANELS. Plastic materials that are fastened to structural members, or to structural panels or sheathing, and that are used as light-transmitting media in exterior walls.

PLASTIC, APPROVED. Any thermoplastic, thermosetting or reinforced thermosetting plastic material that conforms to combustibility classifications specified in the section applicable to the application and plastic type.

PLASTIC GLAZING. Plastic materials that are glazed or set in frame or sash and not held by mechanical fasteners that pass through the glazing material.

REINFORCED PLASTIC, GLASS FIBER. Plastic reinforced with glass fiber having not less than 20 percent of glass fibers by weight.

THERMOPLASTIC MATERIAL. A plastic material that is capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature.

THERMOSETTING MATERIAL. A plastic material that is capable of being changed into a substantially nonreformable product when cured.

SECTION 2603
FOAM PLASTIC INSULATION

2603.1 General. The provisions of this section shall govern the requirements and uses of foam plastic insulation in buildings and structures.

2603.2 Labeling and identification. Packages and containers of foam plastic insulation and foam plastic insulation components delivered to the job site shall bear the label of an approved agency showing the manufacturer's name, the product listing, product identification and information sufficient to determine that the end use will comply with the code requirements.

2603.3 Surface-burning characteristics. Unless otherwise indicated in this section, foam plastic insulation and foam plastic cores of manufactured assemblies shall have a flame spread index of not more than 75 and a smoke-developed index of not more than 450 where tested in the maximum thickness intended for use in accordance with ASTM E 84. Loose fill-type foam plastic insulation shall be tested as board stock for the flame spread index and smoke-developed index.

Exceptions:

1. Smoke-developed index for interior trim as provided for in Section 2604.2.
2. In cold storage buildings, ice plants, food plants, food processing rooms and similar areas, foam plastic insulation where tested in a thickness of 4 inches (102 mm) shall be permitted in a thickness up to 10 inches (254 mm) where the building is equipped throughout with an automatic fire sprinkler system in accordance with Section 903.3.1.1. The approved automatic sprinkler system shall be provided in both the room and that part of the building in which the room is located.
3. Foam plastic insulation that is a part of a Class A, B or C roof-covering assembly provided the assembly with the foam plastic insulation satisfactorily passes FM 4450 or UL 1256. The smoke-developed index shall not be limited for roof applications.
4. Foam plastic insulation greater than 4 inches (102 mm) in thickness shall have a maximum flame spread index of 75 and a smoke-developed index of 450 where tested at a minimum thickness of 4 inches (102 mm), provided the end use is approved in accordance with Section 2603.9 using the thickness and density intended for use.

5. Flame spread and smoke-developed indexes for foam plastic interior signs in covered mall buildings provided the signs comply with Section 402.15.

2603.4 Thermal barrier. Except as provided for in Sections 2603.4.1 and 2603.9, foam plastic shall be separated from the interior of a building by an approved thermal barrier of 0.5-inch (12.7 mm) gypsum wallboard or equivalent thermal barrier material that will limit the average temperature rise of the unexposed surface to not more than 250°F (120°C) after 15 minutes of fire exposure, complying with the standard time-temperature curve of ASTM E 119. The thermal barrier shall be installed in such a manner that it will remain in place for 15 minutes based on FM 4880, UL 1040, NFPA 286 or UL 1715. Combustible concealed spaces shall comply with Section 717.

2603.4.1 Thermal barrier not required. The thermal barrier specified in Section 2603.4 is not required under the conditions set forth in Sections 2603.4.1.1 through 2603.4.1.13.

2603.4.1.1 Masonry or concrete construction. A thermal barrier is not required for foam plastic installed in a masonry or concrete wall, floor or roof system where the foam plastic insulation is covered on each face by a minimum of 1 inch (25 mm) thickness of masonry or concrete.

2603.4.1.2 Cooler and freezer walls. Foam plastic installed in a maximum thickness of 10 inches (254 mm) in cooler and freezer walls shall:

1. Have a flame spread index of 25 or less and a smoke-developed index of not more than 450, where tested in a minimum 4 inch (102 mm) thickness.
2. Have flash ignition and self-ignition temperatures of not less than 600°F and 800°F (316°C and 427°C), respectively.
3. Have a covering of not less than 0.032-inch (0.8 mm) aluminum or corrosion-resistant steel having a base metal thickness not less than 0.0160 inch (0.4 mm) at any point.
4. Be protected by an automatic sprinkler system. Where the cooler or freezer is within a building, both the cooler or freezer and that part of the building in which it is located shall be sprinklered.

2603.4.1.3 Walk-in coolers. In nonsprinklered buildings, foam plastic having a thickness that does not exceed 4 inches (102 mm) and a maximum flame spread index of 75 is permitted in walk-in coolers or freezer units where the aggregate floor area does not exceed 400 square feet (37 m^2) and the foam plastic is covered by a metal facing not less than 0.032-inch-thick (0.81 mm) aluminum or corrosion-resistant steel having a minimum base metal thickness of 0.016 inch (0.41 mm). A thickness of up to 10 inches (254 mm) is permitted where protected by a thermal barrier.

2603.4.1.4 Exterior walls—one-story buildings. For one-story buildings, foam plastic having a flame spread index of 25 or less, and a smoke-developed index of not more than 450, shall be permitted without thermal barriers in or on exterior walls in a thickness not more than 4 inches (102 mm) where the foam plastic is covered by a thickness of not less than 0.032-inch-thick (0.81 mm) aluminum or corrosion-resistant steel having a base metal thickness of 0.0160 inch (0.41 mm) and the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

2603.4.1.5 Roofing. Foam plastic insulation under a roof assembly or roof covering that is installed in accordance with the code and the manufacturer's instructions shall be separated from the interior of the building by wood structural panel sheathing not less than 0.47 inch (11.9 mm) in thickness bonded with exterior glue, with edges supported by blocking, tongue-and-groove joints or other approved type of edge support, or an equivalent material. A thermal barrier is not required for foam plastic insulation that is a part of a Class A, B or C roof-covering assembly, provided the assembly with the foam plastic insulation satisfactorily passes FM 4450 or UL 1256.

2603.4.1.6 Attics and crawl spaces. Within an attic or crawl space where entry is made only for service of utilities, foam plastic insulation shall be protected against ignition by 1.5-inch-thick (38 mm) mineral fiber insulation; 0.25-inch-thick (6.4 mm) wood structural panel, particleboard or hardboard; 0.375-inch (9.5 mm) gypsum wallboard, corrosion-resistant steel having a base metal thickness of 0.016 inch (0.4 mm) or other approved material installed in such a manner that the foam plastic insulation is not exposed. The protective covering shall be consistent with the requirements for the type of construction.

2603.4.1.7 Doors not required to have a fire protection rating. Where pivoted or side-hinged doors are permitted without a fire protection rating, foam plastic insulation, having a flame spread index of 75 or less and a smoke-developed index of not more than 450, shall be permitted as a core material where the door facing is of metal having a minimum thickness of 0.032-inch (0.8 mm) aluminum or steel having a base metal thickness of not less than 0.016 inch (0.4 mm) at any point.

2603.4.1.8 Exterior doors in buildings of Group R-2 or R-3. In occupancies classified as Group R-2 or R-3, foam-filled exterior entrance doors to individual dwelling units that do not require a fire-resistance rating shall be faced with wood or other approved materials.

2603.4.1.9 Garage doors. Where garage doors are permitted without a fire-resistance rating and foam plastic is used as a core material, the door facing shall be metal having a minimum thickness of 0.032-inch (0.8 mm) aluminum or 0.010-inch (0.25 mm) steel or the facing shall be minimum 0.125-inch-thick (3.2 mm) wood. Garage doors having facings other than those described above shall be tested in accordance with, and meet the acceptance criteria of, DASMA 107.

Exception: Garage doors using foam plastic insulation complying with Section 2603.3 in detached and attached garages associated with one- and two-family dwellings need not be provided with a thermal barrier.

2603.4.1.10 Siding backer board. Foam plastic insulation of not more than 2,000 British thermal units per square feet (Btu/sq. ft.) (22.7 MJ/m^2) as determined by NFPA 259 shall be permitted as a siding backer board with a maximum thickness of 0.5 inch (12.7 mm), provided it is separated from the interior of the building by not less than 2 inches (51 mm) of mineral fiber insulation or equivalent or where applied as insulation with re-siding over existing wall construction.

2603.4.1.11 Interior trim. Foam plastic used as interior trim in accordance with Section 2604 shall be permitted without a thermal barrier.

2603.4.1.12 Interior signs. Foam plastic used for interior signs in covered mall buildings in accordance with Section 402.15 shall be permitted without a thermal barrier. Foam plastic signs that are not affixed to interior building surfaces shall comply with the *Florida Fire Prevention Code*.

2603.4.1.13 Type V construction. Foam plastic spray applied to a sill plate and header of Type V construction is subject to all of the following:

1. The maximum thickness of the foam plastic shall be $3^1/_4$ inches (82.6 mm).
2. The density of the foam plastic shall be in the range of 1.5 to 2.0 pcf (24 to 32 kg/m^3).
3. The foam plastic shall have a flame spread index of 25 or less and an accompanying smoke-developed index of 450 or less when tested in accordance with ASTM E 84.

2603.5 Exterior walls of buildings of any height. Exterior walls of buildings of Type I, II, III or IV construction of any height shall comply with Sections 2603.5.1 through 2603.5.7. Exterior walls of cold storage buildings required to be constructed of noncombustible materials, where the building is more than one story in height, shall also comply with the provisions of Sections 2603.5.1 through 2603.5.7. Exterior walls of buildings of Type V construction shall comply with Sections 2603.2, 2603.3 and 2603.4.

2603.5.1 Fire-resistance-rated walls. Where the wall is required to have a fire-resistance rating, data based on tests conducted in accordance with ASTM E 119 shall be provided to substantiate that the fire-resistance rating is maintained.

2603.5.2 Thermal barrier. Any foam plastic insulation shall be separated from the building interior by a thermal barrier meeting the provisions of Section 2603.4, unless special approval is obtained on the basis of Section 2603.9.

Exception: One-story buildings complying with Section 2603.4.1.4.

2603.5.3 Potential heat. The potential heat of foam plastic insulation in any portion of the wall or panel shall not exceed the potential heat expressed in Btu per square feet (MJ/m^2) of the foam plastic insulation contained in the wall assembly tested in accordance with Section 2603.5.5. The potential heat of the foam plastic insulation shall be determined by tests conducted in accordance with NFPA 259 and the results shall be expressed in Btu per square feet (MJ/m^2).

Exception: One-story buildings complying with Section 2603.4.1.4.

2603.5.4 Flame spread and smoke-developed indexes. Foam plastic insulation, exterior coatings and facings shall be tested separately in the thickness intended for use, but not to exceed 4 inches (102 mm), and shall each have a flame spread index of 25 or less and a smoke-developed index of 450 or less as determined in accordance with ASTM E 84.

Exception: Prefabricated or factory-manufactured panels having minimum 0.020-inch (0.51 mm) aluminum facings and a total thickness of 0.25 inch (6.4 mm) or less are permitted to be tested as an assembly where the foam plastic core is not exposed in the course of construction.

2603.5.5 Test standard. The wall assembly shall be tested in accordance with and comply with the acceptance criteria of NFPA 285.

Exception: One-story buildings complying with Section 2603.4.1.4.

2603.5.6 Label required. The edge or face of each piece of foam plastic insulation shall bear the label of an approved agency. The label shall contain the manufacturer's or distributor's identification, model number, serial number or definitive information describing the product or materials' performance characteristics and approved agency's identification.

2603.5.7 Ignition. Exterior walls shall not exhibit sustained flaming where tested in accordance with NFPA 268. Where a material is intended to be installed in more than one thickness, tests of the minimum and maximum thickness intended for use shall be performed.

Exception: Assemblies protected on the outside with one of the following:

1. A thermal barrier complying with Section 2603.4.
2. A minimum 1 inch (25 mm) thickness of concrete or masonry.
3. Glass-fiber-reinforced concrete panels of a minimum thickness of 0.375 inch (9.5 mm).
4. Metal-faced panels having minimum 0.019-inch-thick (0.48 mm) aluminum or 0.016-inch-thick (0.41 mm) corrosion-resistant steel outer facings.
5. A minimum 0.875 inch (22.2 mm) thickness of stucco complying with Section 2510.

2603.6 Roofing. Foam plastic insulation meeting the requirements of Sections 2603.2, 2603.3 and 2603.4 shall be permitted as part of a roof-covering assembly, provided the assembly with the foam plastic insulation is a Class A, B or C roofing assembly where tested in accordance with ASTM E 108 or UL 790.

2603.7 Plenums. Foam plastic insulation shall not be used as interior wall or ceiling finish in plenums except as permitted in Section 2604 or when protected by a thermal barrier in accordance with Section 2603.4.

2603.8 Protection from termite damage.

2603.8.1 Foam-plastic insulation including, but not limited to, extruded or expanded polystyrene or polyisocyanurate shall not be installed below grade on foundation walls or below grade on the exterior of slab foundations.

Exceptions:

1. When in addition to the requirements of Section 2304.11.6, an approved method of protecting the foam plastic and structure from subterranean termite damage is provided.
2. Within Types I and II-B construction.
3. On the interior side of basement walls.

2603.8.2 Clearance between earth and foam plastics applied to the exterior wall shall be not less than 6 inches (152 mm).

Figure 2603.8 Termite Infestation Probability Map. Reserved.

2603.9 Special approval. Foam plastic shall not be required to comply with the requirements of Sections 2603.4 through 2603.7 where specifically approved based on large-scale tests such as, but not limited to, NFPA 286 (with the acceptance criteria of Section 803.2), FM 4880, UL 1040 or UL 1715. Such testing shall be related to the actual end-use configuration and be performed on the finished manufactured foam plastic assembly in the maximum thickness intended for use. Foam plastics that are used as interior finish on the basis of special tests shall also conform to the flame spread requirements of Chapter 8. Assemblies tested shall include seams, joints and other typical details used in the installation of the assembly and shall be tested in the manner intended for use.

SECTION 2604 INTERIOR FINISH AND TRIM

2604.1 General. Plastic materials installed as interior finish or trim shall comply with Chapter 8. Foam plastics shall only be installed as interior finish where approved in accordance with the special provisions of Section 2603.9. Foam plastics that are used as interior finish shall also meet the flame spread index requirements for interior finish in accordance with Chapter 8. Foam plastics installed as interior trim shall comply with Section 2604.2.

[F] 2604.2 Interior trim. Foam plastic used as interior trim shall comply with Sections 2604.2.1 through 2604.2.4.

[F] 2604.2.1 Density. The minimum density of the interior trim shall be 20 pcf (320 kg/m^3).

[F] 2604.2.2 Thickness. The maximum thickness of the interior trim shall be 0.5 inch (12.7 mm) and the maximum width shall be 8 inches (204 mm).

[F] 2604.2.3 Area limitation. The interior trim shall not constitute more than 10 percent of the aggregate wall and ceiling area of any room or space.

[F] 2604.2.4 Flame spread. The flame spread index shall not exceed 75 where tested in accordance with ASTM E 84. The smoke-developed index shall not be limited.

SECTION 2605 PLASTIC VENEER

2605.1 Interior use. Where used within a building, plastic veneer shall comply with the interior finish requirements of Chapter 8.

2605.2 Exterior use. Exterior plastic veneer shall be permitted to be installed on the exterior walls of buildings of any type of construction in accordance with all of the following requirements:

1. Plastic veneer shall comply with Section 2606.4.
2. Plastic veneer shall not be attached to any exterior wall to a height greater than 50 feet (15 240 mm) above grade.
3. Sections of plastic veneer shall not exceed 300 square feet (27.9 m^2) in area and shall be separated by a minimum of 4 feet (1219 mm) vertically.

Exception: The area and separation requirements and the smoke-density limitation are not applicable to plastic veneer applied to buildings constructed of Type VB construction, provided the walls are not required to have a fire-resistance rating.

SECTION 2606 LIGHT-TRANSMITTING PLASTICS

2606.1 General. The provisions of this section and Sections 2607 through 2611 shall govern the quality and methods of application of light-transmitting plastics for use as light-transmitting materials in buildings and structures. Foam plastics shall comply with Section 2603. Light-transmitting plastic materials that meet the other code requirements for walls and roofs shall be permitted to be used in accordance with the other applicable chapters of the code.

2606.2 Approval for use. Sufficient technical data shall be submitted to substantiate the proposed use of any light-transmitting material, as approved by the building official and subject to the requirements of this section.

2606.3 Identification. Each unit or package of light-transmitting plastic shall be identified with a mark or decal satisfactory to the building official, which includes identification as to the material classification.

2606.4 Specifications. Light-transmitting plastics, including thermoplastic, thermosetting or reinforced thermosetting plastic material, shall have a self-ignition temperature of 650°F (343°C) or greater where tested in accordance with ASTM D 1929; a smoke-developed index not greater than 450 where tested in the manner intended for use in accordance with ASTM E 84, or not greater than 75 where tested in the thickness intended for use in accordance with ASTM D 2843 and shall conform to one of the following combustibility classifications:

Class CC1: Plastic materials that have a burning extent of 1 inch (25 mm) or less where tested at a nominal thickness of 0.060 inch (1.5 mm), or in the thickness intended for use, in accordance with ASTM D 635,

Class CC2: Plastic materials that have a burning rate of 2.5 inches per minute (1.06 mm/s) or less where tested at a nominal thickness of 0.060 inch (1.5 mm), or in the thickness intended for use, in accordance with ASTM D 635.

2606.5 Structural requirements. Light-transmitting plastic materials in their assembly shall be of adequate strength and durability to withstand the loads indicated in Chapter 16. Technical data shall be submitted to establish stresses, maximum unsupported spans and such other information for the various thicknesses and forms used as deemed necessary by the building official.

2606.6 Fastening. Fastening shall be adequate to withstand the loads in Chapter 16. Proper allowance shall be made for expansion and contraction of light-transmitting plastic materials in accordance with accepted data on the coefficient of expansion of the material and other material in conjunction with which it is employed.

2606.7 Light-diffusing systems. Unless the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, light-diffusing systems shall not be installed in the following occupancies and locations:

1. Group A with an occupant load of 1,000 or more.
2. Theaters with a stage and proscenium opening and an occupant load of 700 or more.
3. Group I-2.
4. Group I-3.
5. Exit stairways and exit passageways.

2606.7.1 Support. Light-transmitting plastic diffusers shall be supported directly or indirectly from ceiling or roof construction by use of noncombustible hangers. Hangers shall be at least No. 12 steel-wire gage (0.106 inch) galvanized wire or equivalent.

2606.7.2 Installation. Light-transmitting plastic diffusers shall comply with Chapter 8 unless the light-transmitting plastic diffusers will fall from the mountings before igniting, at an ambient temperature of at least 200°F (111°C) below the ignition temperature of the panels. The panels shall remain in place at an ambient room temperature of 175°F (79°C) for a period of not less than 15 minutes.

2606.7.3 Size limitations. Individual panels or units shall not exceed 10 feet (3048 mm) in length nor 30 square feet (2.79 m^2) in area.

2606.7.4 Fire suppression system. In buildings that are equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, plastic light-diffusing systems shall be protected both above and below unless the sprinkler system has been specifically approved for installation only above the light-diffusing system. Areas of light-diffusing systems that are protected in accordance with this section shall not be limited.

2606.7.5 Electrical luminaires. Light-transmitting plastic panels and light-diffuser panels that are installed in approved electrical luminaires shall comply with the requirements of Chapter 8 unless the light-transmitting plastic panels conform to the requirements of Section 2606.7.2. The area of approved light-transmitting plastic materials that are used in required exits or corridors shall not exceed 30 percent of the aggregate area of the ceiling in which such panels are installed, unless the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

2606.8 Partitions. Light-transmitting plastics used in or as partitions shall comply with the requirements of Chapters 6 and 8.

2606.9 Bathroom accessories. Light-transmitting plastics shall be permitted as glazing in shower stalls, shower doors, bathtub enclosures and similar accessory units. Safety glazing shall be provided in accordance with Chapter 24.

2606.10 Awnings, patio covers and similar structures. Awnings constructed of light-transmitting plastics shall be constructed in accordance with the provisions specified in Section 3105 and Chapter 32 for projections. Patio covers constructed of light-transmitting plastics shall comply with Section 2606. Light-transmitting plastics used in canopies at motor fuel-dispensing facilities shall comply with Section 2606, except as modified by Section 406.5.2.

2606.11 Greenhouses. Light-transmitting plastics shall be permitted in lieu of plain glass in greenhouses.

2606.12 Solar collectors. Light-transmitting plastic covers on solar collectors having noncombustible sides and bottoms shall be permitted on buildings not over three stories in height or 9,000 square feet (836.1 m^2) in total floor area, provided the light-transmitting plastic cover does not exceed 33.33 percent of the roof area for CC1 materials or 25 percent of the roof area for CC2 materials.

Exception: Light-transmitting plastic covers having a thickness of 0.010 inch (0.3 mm) or less or shall be permitted to be of any plastic material provided the area of the solar collectors does not exceed 33.33 percent of the roof area.

SECTION 2607
LIGHT-TRANSMITTING PLASTIC WALL PANELS

2607.1 General. Light-transmitting plastics shall not be used as wall panels in exterior walls in occupancies in Groups A-l, A-2, H, I-2 and I-3. In other groups, light-transmitting plastics shall be permitted to be used as wall panels in exterior walls, provided that the walls are not required to have a fire-resistance rating and the installation conforms to the requirements of this section. Such panels shall be erected and anchored on a foundation, waterproofed or otherwise protected from moisture absorption and sealed with a coat of mastic or other approved waterproof coating. Light-transmitting plastic wall panels shall also comply with Section 2606.

2607.2 Installation. Exterior wall panels installed as provided for herein shall not alter the type of construction classification of the building.

2607.3 Height limitation. Light-transmitting plastics shall not be installed more than 75 feet (22 860 mm) above grade plane, except as allowed by Section 2607.5.

2607.4 Area limitation and separation. The maximum area of a single wall panel and minimum vertical and horizontal separation requirements for exterior light-transmitting plastic wall panels shall be as provided for in Table 2607.4. The maximum percentage of wall area of any story in light-transmitting plastic wall panels shall not exceed that indicated in Table 2607.4 or the percentage of unprotected openings permitted by Section 704.8, whichever is smaller.

Exceptions:

1. In structures provided with approved flame barriers extending 30 inches (760 mm) beyond the exterior wall in the plane of the floor, a vertical separation is not required at the floor except that provided by the vertical thickness of the flame barrier projection.
2. Veneers of approved weather-resistant light-transmitting plastics used as exterior siding in buildings of Type V construction in compliance with Section 1406.
3. The area of light-transmitting plastic wall panels in exterior walls of greenhouses shall be exempt from the area limitations of Table 2607.4 but shall be limited as required for unprotected openings in accordance with Section 704.8.

2607.5 Automatic sprinkler system. Where the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, the maximum percentage area of exterior wall in any story in light-transmitting plastic wall panels and the maximum square footage of a single area given in Table 2607.4 shall be increased 100 percent, but the area of light-transmitting plastic wall panels shall not exceed 50 percent of the wall area in any story, or the area permitted by Section 704.8 for unprotected openings, whichever is smaller. These installations shall be exempt from height limitations.

2607.6 Combinations of glazing and wall panels. Combinations of light-transmitting plastic glazing and light-transmitting plastic wall panels shall be subject to the area, height and percentage limitations and the separation requirements applicable to the class of light-transmitting plastic as prescribed for light-transmitting plastic wall panel installations.

SECTION 2608 LIGHT-TRANSMITTING PLASTIC GLAZING

2608.1 Buildings of Type VB construction. Openings in the exterior walls of buildings of Type VB construction, where not required to be protected by Section 704, shall be permitted to be glazed or equipped with light-transmitting plastic. Light-transmitting plastic glazing shall also comply with Section 2606.

2608.2 Buildings of other types of construction. Openings in the exterior walls of buildings of types of construction other than Type VB, where not required to be protected by Section 704, shall be permitted to be glazed or equipped with light-transmitting plastic in accordance with Section 2606 and all of the following:

1. The aggregate area of light-transmitting plastic glazing shall not exceed 25 percent of the area of any wall face of the story in which it is installed. The area of a single pane of glazing installed above the first story above grade plane shall not exceed 16 square feet (1.5 m^2) and the vertical dimension of a single pane shall not exceed 4 feet (1219 mm).

   Exception: Where an automatic sprinkler system is provided throughout in accordance with Section 903.3.1.1, the area of allowable glazing shall be increased to a maximum of 50 percent of the wall face of the story in which it is installed with no limit on the

TABLE 2607.4
AREA LIMITATION AND SEPARATION REQUIREMENTS FOR LIGHT-TRANSMITTING PLASTIC WALL PANELS[a]

FIRE SEPARATION DISTANCE (feet)	CLASS OF PLASTIC	MAXIMUM PERCENTAGE AREA OF EXTERIOR WALL IN PLASTIC WALL PANELS	MAXIMUM SINGLE AREA OF PLASTIC WALL PANELS (square feet)	MINIMUM SEPARATION OF PLASTIC WALL PANELS (feet)	
				Vertical	Horizontal
Less than 6	—	Not Permitted	Not Permitted	—	—
6 or more but less than 11	CC1	10	50	8	4
	CC2	Not Permitted	Not Permitted	—	—
11 or more but less than or equal to 30	CC1	25	90	6	4
	CC2	15	70	8	4
Over 30	CC1	50	Not Limited	3[b]	0
	CC2	50	100	6[b]	3

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2.

a. For combinations of plastic glazing and plastic wall panel areas permitted, see Section 2607.6.

b. For reductions in vertical separation allowed, see Section 2607.4.

maximum dimension or area of a single pane of glazing.

2. Approved flame barriers extending 30 inches (762 mm) beyond the exterior wall in the plane of the floor, or vertical panels not less than 4 feet (1219 mm) in height, shall be installed between glazed units located in adjacent stories.

   Exception: Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

3. Light-transmitting plastics shall not be installed more than 75 feet (22 860 mm) above grade level.

   Exception: Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

SECTION 2609
LIGHT-TRANSMITTING PLASTIC ROOF PANELS

2609.1 General. Light-transmitting plastic roof panels shall comply with this section and Section 2606. Light-transmitting plastic roof panels shall not be installed in Groups H, I-2 and I-3. In all other groups, light-transmitting plastic roof panels shall comply with any one of the following conditions:

1. The building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.
2. The roof construction is not required to have a fire-resistance rating by Table 601.
3. The roof panels meet the requirements for roof coverings in accordance with Chapter 15.

2609.2 Separation. Individual roof panels shall be separated from each other by a distance of not less than 4 feet (1219 mm) measured in a horizontal plane.

Exceptions:

1. The separation between roof panels is not required in a building equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.
2. The separation between roof panels is not required in low-hazard occupancy buildings complying with the conditions of Section 2609.4, Exception 2 or 3.

2609.3 Location. Where exterior wall openings are required to be protected by Section 704.8, a roof panel shall not be installed within 6 feet (1829 mm) of such exterior wall.

2609.4 Area limitations. Roof panels shall be limited in area and the aggregate area of panels shall be limited by a percentage of the floor area of the room or space sheltered in accordance with Table 2609.4.

Exceptions:

1. The area limitations of Table 2609.4 shall be permitted to be increased by 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.
2. Low-hazard occupancy buildings, such as swimming pool shelters, shall be exempt from the area limitations of Table 2609.4, provided that the buildings do not exceed 5,000 square feet (465 m^2) in area and have a minimum fire separation distance of 10 feet (3048 mm).
3. Greenhouses that are occupied for growing plants on a production or research basis, without public access, shall be exempt from the area limitations of Table 2609.4 provided they have a minimum fire separation distance of 4 feet (1220 mm).
4. Roof coverings over terraces and patios in occupancies in Group R-3 shall be exempt from the area limitations of Table 2609.4 and shall be permitted with light-transmitting plastics.

TABLE 2609.4
AREA LIMITATIONS FOR LIGHT-TRANSMITTING PLASTIC ROOF PANELS

CLASS OF PLASTIC	MAXIMUM AREA OF INDIVIDUAL ROOF PANELS (square feet)	MAXIMUM AGGREGATE AREA OF ROOF PANELS (percent of floor area)
CC1	300	30
CC2	100	25

For SI: 1 square foot = 0.0929 m^2.

SECTION 2610
LIGHT-TRANSMITTING PLASTIC SKYLIGHT GLAZING

2610.1 Light-transmitting plastic glazing of skylight assemblies. Skylight assemblies glazed with light-transmitting plastic shall conform to the provisions of this section and Section 2606. Unit skylights glazed with light-transmitting plastic shall also comply with Section 2405.5.

Exception: Skylights in which the light-transmitting plastic conforms to the required roof-covering class in accordance with Section 1505.

2610.2 Mounting. The light-transmitting plastic shall be mounted above the plane of the roof on a curb constructed in accordance with the requirements for the type of construction classification, but at least 4 inches (102 mm) above the plane of the roof. Edges of light-transmitting plastic skylights or domes shall be protected by metal or other approved noncombustible material, or the light-transmitting plastic dome or skylight shall be shown to be able to resist ignition where exposed at the edge to a flame from a Class B brand as described in ASTM E 108 or UL 790.

Exceptions:

1. Curbs shall not be required for skylights used on roofs having a minimum slope of three units vertical in 12 units horizontal (25-percent slope) in occupancies in Group R-3 and on buildings with a nonclassified roof covering.
2. The metal or noncombustible edge material is not required where nonclassified roof coverings are permitted.

2610.3 Slope. Flat or corrugated light-transmitting plastic skylights shall slope at least four units vertical in 12 units horizontal (4:12). Dome-shaped skylights shall rise above the mounting flange a minimum distance equal to 10 percent of the maximum span of the dome but not less than 3 inches (76 mm).

Exception: Skylights that pass the Class B Burning Brand Test specified in ASTM E 108 or UL 790.

2610.4 Maximum area of skylights. Each skylight shall have a maximum area within the curb of 100 square feet (9.3 m^2).

Exception: The area limitation shall not apply where the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or the building is equipped with smoke and heat vents in accordance with Section 910.

2610.5 Aggregate area of skylights. The aggregate area of skylights shall not exceed $33^1/_3$ percent of the floor area of the room or space sheltered by the roof in which such skylights are installed where Class CC1 materials are utilized, and 25 percent where Class CC2 materials are utilized.

Exception: The aggregate area limitations of light-transmitting plastic skylights shall be increased 100 percent beyond the limitations set forth in this section where the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or the building is equipped with smoke and heat vents in accordance with Section 910.

2610.6 Separation. Skylights shall be separated from each other by a distance of not less than 4 feet (1219 mm) measured in a horizontal plane.

Exceptions:

1. Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.
2. In Group R-3, multiple skylights located above the same room or space with a combined area not exceeding the limits set forth in Section 2610.4.

2610.7 Location. Where exterior wall openings are required to be protected in accordance with Section 704, a skylight shall not be installed within 6 feet (1829 mm) of such exterior wall.

2610.8 Combinations of roof panels and skylights. Combinations of light-transmitting plastic roof panels and skylights shall be subject to the area and percentage limitations and separation requirements applicable to roof panel installations.

SECTION 2611
LIGHT-TRANSMITTING PLASTIC INTERIOR SIGNS

2611.1 General. Light-transmitting plastic interior wall signs shall be limited as specified in Sections 2611.2 through 2611.4. Light-transmitting plastic interior wall signs in covered mall buildings shall comply with Section 402.15. Light-transmitting plastic interior signs shall also comply with Section 2606.

2611.2 Aggregate area. The sign shall not exceed 20 percent of the wall area.

2611.3 Maximum area. The sign shall not exceed 24 square feet (2.23 m^2).

2611.4 Encasement. Edges and backs of the sign shall be fully encased in metal.

SECTION 2612
HIGH-VELOCITY HURRICANE ZONES — PLASTICS

2612.1 General.

2612.1.1 Plastic materials used as structural elements shall be designed by methods admitting of rational analysis according to established principles of mechanics.

2612.1.2 Plastic materials may be permitted as set forth herein. The physical properties, such as, not but limited to, weather-resistance, fire-resistance and flame spread characteristics, shall comply with the requirements of this code.

2612.1.3 Application and plans submitted for proposed construction shall identify the plastic material intended for use and such material shall be stamped or otherwise marked so as to be readily identifiable in the field.

2612.1.4 Plastic structural elements, other than sheets, shall be designed by a Florida-registered professional engineer or a Florida-registered architect.

2612.2 Definitions.

APPROVED FOAM PLASTIC. An approved foam plastic shall be any thermoplastic, thermosetting or reinforced thermosetting plastic material that has a minimum self-ignition temperature of 650ºF (343ºC) or greater when tested in accordance with ASTM D 1929. It shall have a smoke density rating not greater than 450 and a flame spread of 75 or less when tested in accordance with ASTM E 84.

APPROVED PLASTIC. An approved plastic shall be any thermoplastic, thermosetting or reinforced thermosetting plastic material which has a self-ignition temperature of 650ºF (343ºC), or greater when tested in accordance with ASTM D 1929, a smoke density rating no greater than 450 when tested in the way intended for use by ASTM E 84 or a smoke density rating no greater than 75 when tested in the thickness intended for use according to ASTM D 2843 and which meets one of the following combustibility classifications:

Class C-1. Plastic materials that have a burning extent of 1 inch per minute (25.4 mm) or less when tested in nominal 0.060 inch (1.5 mm) thickness or in the thickness intended for use by ASTM D 635.

Class C-2. Plastic materials that have a burning rate of $2^1/_2$ inches (64 mm) per minute or less when tested in nominal 0.060 inch (1.5 mm) thickness or in the thickness intended for use by ASTM D 635.

Approved plastics for outdoor exposure shall be evaluated for outdoor durability in accordance with the *Voluntary Standard Uniform Load Test Procedure for Thermoformed Plastic Domed Skylights,* of the AAMA/WDMA 101/IS2/NAFS, *Voluntary Performance Specification for Windows, Skylights and Glass Doors,* as follows:

1. Outdoor exposure conditions: Specimen exposed in Florida at 45 degree south exposure for a period of five years.
   a. Impact testing, after exposure test as above, per ASTM D 256, and
   b. Tensile testing on controlled and weathered specimen per ASTM D 638. Yield strength difference between controlled and weathered specimen shall not exceed 10 percent.
2. Alternate:
   a. Exposure to xenon arc weatherometer using a 6500-watt lamp per ASTM G 155 and ASTM D 2565 for a period of 4,500 hours.
   b. Impact testing, after exposure test as above, per ASTM D 256, and
   c. Tensile testing on controlled and weathered specimen per ASTM D 638. Yield strength difference between controlled and weathered specimen shall not exceed 10 percent.

FINISH RATING. The time, as determined in accordance with ASTM E 119, at which a thermal barrier reaches a temperature rise of 240ºF (116ºC) , above ambient or an individual temperature rise of 324ºF (162ºC), above ambient as measured on the plane of the thermal barrier nearest to foam plastic.

FLAME SPREAD RATING. The measurement of flame spread on the surface of materials or their assemblies as determined in accordance with ASTM E 84.

GLASS FINER REINFORCED PLASTIC. Plastic reinforced with glass fibers having not less than 20 percent of glass fibers by weight.

LIGHT DIFFUSING SYSTEM. A suspended construction consisting in whole or in part of lenses, panels, grids or baffles suspended below independently mounted electrical lighting sources.

PLASTIC GLAZING. Plastic materials that are glazed or set in frame or sash and not held by mechanical fasteners which pass through the glazing material.

PLASTIC ROOF PANELS. Plastic materials that are fastened to structural panels or sheathing and which are used as light transmitting media in the plane of the roof.

PLASTIC SANDWICH PANELS. Panels of foam plastic sandwiched between incombustible skins.

PLASTIC WALL PANELS. Plastic materials that are fastened to structural panels or sheathing and which are used as light transmitting medium in exterior walls.

SKYLIGHT. An assembly that includes plastic materials used as light transmitting medium and which is located above the plane of the roof.

SMOKE DENSITY. A numerical value of smoke development, determined by measuring the area under the curve of light absorption versus time, in accordance with ASTM E 84 or ASTM D 2843.

THERMOPLASTIC MATERIALS. A plastic material that is capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature.

THERMOSETTING MATERIALS. A plastic material that is capable of being changed into a substantially nonreformable product when cured.

2612.3 Foam plastics.

2612.3.1 General.

2612.3.1.1 Except as otherwise provided herein, all foam plastics or foam plastic cores in manufactured assemblies used in building construction shall have a flame spread rating of not more than 75 and shall have a smoke-developed rating of not more than 450 when tested in the maximum thickness intended for use in accordance with ASTM E 84.

2612.3.1.2 Except as otherwise provided herein, foam plastics shall be separated from the interior walls, floors and ceiling herein of a building by an approved thermal barrier of $^1/_2$ inch (13 mm) gypsum wallboard or equivalent thermal barrier material which will limit the average temperature rise of the unexposed surface to not more than 259ºF (126ºC), after 15 minutes of fire exposure complying with the ASTM E 119 standard time-temperature curve.

2612.3.1.3 Foam plastics trim, defined as picture molds, chair rails, baseboards, handrails, ceiling beams, door trim and window trim, shall also meet requirements for interior finish in Section 805.

2612.3.1.4 Foam plastic not meeting the requirements of this section may be specifically approved on the basis of approved tests such as, but not limited to, a tunnel test in accordance with ASTM E 84, FM procedure 4880, UL Subject 1040, ASTM E 152 or the room test procedure described in SPI Bulletin PPICC 401 or fire tests related to actual end-use configuration. The specific approval may be based on the end use, quantity, location and similar considerations where such tests would not be applicable or practical.

2612.3.2 Specific requirements. The following specific requirements shall apply to all uses of foam plastics unless otherwise permitted in this code.

2612.3.2.1 Cold storage buildings.

2612.3.2.1.1 Foam plastics when tested in a thickness of 4 inches (102 mm), may be used in a thickness up to 10 inches (254 mm) when the building is equipped with an approved automatic fire suppression system.

2612.3.2.1.2 Such approved automatic fire suppression system shall be provided in both the cold storage room and the part of the building in which the room is located.

2612.3.2.2 Walk-in coolers.

2612.3.2.2.1 Foam plastic having a maximum flame spread of 75 may be used in a thickness up to 4 inches (102 mm) in free-standing walk-in cooler or freezer units less than 400 square feet (37 m^2) in floor area without a thermal barrier and without an automatic fire suppression system when the foam plastic is covered by a metal facing not less than 0.032 inch (0.813 mm) thick aluminum or corrosion-resistant steel having a minimum of base metal thickness of 0.016 inch (0.406 mm).

2612.3.2.2.2 When protected by a thermal barrier, the foam plastic may be used in a thickness up to 10 inches (254 mm).

2612.3.2.3 Exterior walls of one-story buildings.

2612.3.2.3.1 Foam-plastic insulation having a flame spread of 25 or less may be used without thermal barriers in or on exterior fire resistive incombustible walls in a thickness of not less than 0.032 inch (0.813 mm) aluminum or corrosion-resistant steel having a minimum base metal thickness of 0.0160 inch (0.406 mm), and the insulated interior area is protected with automatic sprinklers.

2612.3.2.3.2 Foam plastic may be used without the thermal barrier described herein when it is protected by a minimum of 1 inch (25.4 mm) thickness of masonry or concrete.

2612.3.2.4 Exterior walls of multistory buildings.

2612.3.2.4.1 Where walls face a street or permanent open space of 30 feet (9 m) or more, foam-plastic insulation may be used in a nonfire-rated exterior wall assembly.

2612.3.2.4.2 Where a separation of less than 30 feet (9 m) exists, foam plastic may be used within exterior walls, provided the wall assembly affords the required fire resistivity.

2612.3.2.4.3 Foam-plastic insulation shall be separated from the building interior by a thermal barrier having an index of 15 unless a specific approval is obtained on the basis of Section 2612.3.1.4.

2612.3.2.4.4 The amount of foam plastic in any portion of the wall or panel shall not exceed 6000 Btu/square foot (68.1 MJ/m^2) of projected area as determined by tests conducted in accordance with NFPA 259.

2612.3.2.4.5 The foam plastic core, coatings and facings shall have a flame spread rating of 25 or less and smoke-developed rating of 450 or less as determined in accordance with ASTM E 84.

2612.3.2.4.6 Facing, coating and core materials shall be mechanically or adhesively fastened to each other and to building members to prohibit failure in bond as a result of temperatures which may be experienced in a building fire from wind loads or other conditions.

2612.3.2.4.7 Results of diversified or full-scale fire tests reflecting an end-use configuration shall be submitted to the building official demonstrating the assembly in its final form does not propagate the flame over the surface or through the core when exposed on the exterior face to a fire source.

2612.3.2.5 Roofing.

2612.3.2.5.1 Foam plastic may be used in a roof covering assembly without the thermal barrier when the foam is separated from the interior of the building by plywood sheathing not less than $^1/_2$ inch (12.7 mm) in thickness bonded with exterior glue, with edge supported by blocking, tongue-and-grooved joints or other approved type of edge support, or an equivalent or better material or system.

2612.3.2.5.2 Foam-plastic roof insulation that complies with FM 4450 or UL 1256 need not meet the requirements of Section 2612.3.1.2.

2612.3.2.5.3 For all roof applications, the smoke developed rating shall not be limited.

2612.3.2.6 Attics and crawl spaces.

2612.3.2.6.1 Within an attic or crawl space where entry is made for service of utilities, exposed foam plastics shall be protected against ignition by 1-inch-thick (25 mm) mineral fiber insulation, $^1/_4$-inch-thick (6.4 mm) plywood, particleboard or hardboard or $^3/_8$-inch (9.5 mm) gypsum wall board, corrosion-resistant steel having a base metal thickness of 0.0160 inch (0.406 mm), or other equivalent material installed in such manner that the foam plastic is not exposed.

2612.3.2.6.2 The protective covering shall also meet the requirements for the type of construction.

2612.3.2.7 Doors.

2612.3.2.7.1 Where doors are permitted without a fire-resistance rating, foam plastic having a flame spread rating of 75 or less may be used as a core material when the door facing is metal having a minimum thickness of 0.032 inch (0.813 mm) aluminum or sheet steel having a minimum thickness of 0.0160 inch (0.406 mm).

2612.3.2.7.2 There shall be no thermal barrier requirements for these doors.

2612.4 Light-transmitting plastics.

2612.4.1 General.

2612.4.1.1 The provisions of this section shall govern the quality and methods of application of plastics for use as light transmitting media within buildings and structures.

2612.4.1.2 All plastics to be used according to the provisions of this section shall be approved plastic and conform to Section 2612.1 and Section 2612.2.

Exception: Roof coverings over terraces and patios of one- and two-family dwellings shall be permitted with approved plastics.

2612.4.2 Glazing of openings in nonfire-rated walls.

2612.4.2.1 Doors, sash and framed openings which are not required to be fire rated may be glazed with approved plastic materials in buildings of Type III-B construction.

2612.4.2.2 In all other types of construction openings not required to be fire-rated may be glazed or equipped with approved plastic material subject to the requirements listed below.

2612.4.2.2.1 The area of such glazing shall not exceed 25 percent of the wall face of the story in which it is installed.

2612.4.2.2.2 The area of a unit or pane of glazing installed above the first story shall not exceed 16 square feet (1.49 m^2) and the vertical dimension of a unit or pane shall not exceed 4 feet (1219 mm). There shall be a minimum 3 feet (914 mm) vertical spandrel wall between stories.

2612.4.2.2.3 Approved plastics shall not be installed more than 75 feet (22.9 m) above grade level except as provided in Section 2612.4.2.2.4.

2612.4.2.2.4 Approved thermoplastic materials may be installed in areas up to 50 percent of the wall area of each story in structures less than 150 feet (45.7 m) in height if continuous architectural projections constitute an effective fire barrier extending at least 3 feet (914 mm) from the surface of the wall on which the glazing is installed and are provided on each floor above the first floor. The size and the dimensions of individual units shall not be limited in such installations except as required to meet structural loading requirements.

2612.4.2.3 Area increase based on fire protection. In buildings or portions thereof protected by approved automatic, fire extinguishing systems, the area of glazing permitted by Section 2612.4.2.2.1 may be increased by 100 percent.

2612.4.3 Exterior nonfire-rated wall panels.

2612.4.3.1 General. Approved plastic materials may be used as wall panels, in exterior walls not required to heave a fire rating subject to the requirements in this section.

2612.4.3.1.1 Installation. Exterior wall panels installed as provided herein shall not alter the type of construction classification of the building.

2612.4.3.1.2 Height limitation. Approved plastics shall not be installed more than 75 feet (22.9 m) above grade level except as permitted by Section 2612.4.3.1.4 (Exception 3).

2612.4.3.1.3 Area limitation and separation. Area limitation and separation requirements of exterior wall panels shall be provided in Table 2612.4.3.1.3.

2612.4.3.1.4 Combination of glazing and wall panels. Combinations of plastic glazing and plastic wall panels shall be subject to the area, height and percentage limitations and separation requirements applicable to the class of plastics as prescribed for wall panel installations.

Exceptions:

1. Structures which provide continuous architectural projections extending at least 36 inches (914 mm) from the surface of the wall in which plastic wall panels are installed shall not be required to provide vertical separation at that floor.
2. Area increase based on in fire protection. In buildings or portions thereof protected by approved automatic fire extinguishing systems, the maximum percent area of plastic panes in exterior walls and the maximum square feet of separate panel are given in Table 2612.4.3.1.3 may be increased 100 percent but the area of plastic wall panels shall not exceed 50 percent of the wall area.
3. Approved thermoplastic materials may be installed in areas up to 50 percent of the wall area of each story in structures less than 150 feet (45.7 m) in width if continuous architectural projections constitute an effective fire barrier extending at least 3 feet (914 mm) from the surface of the wall on which the panels are installed and are provided on each floor above the first floor.
4. The use of plastics shall not be permitted in exterior walls in Group A, H and I occupancies.

TABLE 2612.4.3.1.3
AREA LIMITATION AND SEPARATION REQUIREMENTS FOR PLASTIC WALL PANELS IN NONFIRE-RATED WALLS

FIRE SEPARATION (FT)	CLASS OF PLASTIC	MAX. AGGREGATE AREA (% OF EXTERIOR WALL)	MAX. SEPARATED PANEL AREA (SQ FT)	MINIMUM SEPARATION OF PANELS (FT)	
				VERTICAL	HORIZONTAL
10 up to and including 30.	C1 C2	25 15	90 70	6 8	4 4
Over 30	C1 C2	50 50	no limit 100	3[1] 6[1]	0 3

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2.
Note 1: See Exception 1 to Section 2612.4.3.1.

2612.4.4 Roof panels.

2612.4.4.1 General. Approved plastic roof panels may be installed as follows.

2612.4.4.1.1 Where the roof is not required to have a fire rating.

2612.4.4.1.2 Where the roof panels meet the requirements for roof coverings of the particular occupancy.

2612.4.4.1.3 In roofs of buildings protected by an approved automatic fire-extinguishing system.

Exception: The use of plastics shall not be permitted in roofs of Group A, H and I occupancies.

2612.4.4.2 Separations. Individual roof panels shall be separated from each other by a distance of not less than 4 feet (1219 mm) measured in a horizontal plane.

2612.4.4.3 Location. Where exterior wall openings are required to be fire rated, a roof panel or unit shall not be installed within 6 feet (1829 mm) of such exterior wall.

2612.4.4.4 Area limitations. Roof panels or units shall be limited in area, according to provisions set forth in Table 2612.4.4.4.

2612.4.5 Skylight assemblies. Skylight assemblies may be glazed with approved plastic materials in accordance with this section.

2612.4.5.1 Mounting.

2612.4.5.1.1 The plastic shall be mounted a minimum of 4 inches (102 mm) above the plane of the roof on a curb constructed in accordance with requirements of types of construction.

2612.4.5.1.2 Dome-shape skylights shall rise above the mounting flange a minimum distance equal to 10 percent of the maximum span of the dome, but not less than 4 inches (102 mm).

2612.4.5.1.3 The edges of the skylights shall be protected by incombustible material in Types I, IV and V-B construction.

2612.4.5.2 Maximum area of skylight units. Each skylight unit shall have a maximum area within the curb of 100 square feet (9.3 m^2) for Class C-2 material and 200 square feet (18.6 m^2) for Class C-1 material.

2612.4.5.3 Aggregate area of skylights. The aggregate area of skylights shall not exceed 33 percent when Class C-1 materials are used and 25 percent when Class C-2 materials are used, of the floor area of the room or space sheltered by the roof in which they are installed.

2612.4.5.4 Separation. Skylights shall be separated from each other by a distance of not less than 4 feet (1219 mm) measured in a horizontal plane.

2612.4.5.5 Location. Where exterior wall openings are required to be fire rated, a skylight shall not be installed within 6 feet (1829 mm) of such exterior wall.

Exceptions:

1. Skylight assemblies may not be glazed with approved plastic materials in buildings of Group H and I occupancies.
2. The aggregated area of approved plastic skylights may be increased 100 percent beyond the limitations set forth herein if the skylights are used as an automatic fire venting system or if the building is equipped with an automatic fire extinguishing system.
3. When a building not more than one story in height has a minimum distance separation from other buildings of 30 feet (9.1 m) and is not used as an enclosed means of egress, skylights in such a building need not comply with the requirements set forth in this paragraph.
4. When skylights used in a building are made of approved plastic materials that meet the fire-rated requirements of the roof of the building, such skylight assemblies need not comply with the requirements set forth in this paragraph.
5. Skylights installed in detached buildings of Group R3 occupancy, Types IV and III-B need not comply with this section.

2612.4.6 Light diffusing systems.

2612.4.6.1 General.

2612.4.6.1.1 Light diffusing systems shall not be installed in Group I and H occupancies or in exitways unless they are protected with an approved automatic fire extinguishing system.

2612.4.6.1.2 Approved plastic diffusers shall comply with the flame spread requirements for interior finishes, unless the individual plastic panels will fall from their mountings before igniting at an ambient temperature of at least 200ºF (93ºC) below their ignition temperature. The panels must, however, remain in place at an ambient room temperature of 175ºF (79ºC) for a period of not less than 15 minutes.

2612.4.6.1.3 Location. Where fire-rated ceiling assemblies are required, plastic diffusers, if used, shall be located below such assemblies.

2612.4.6.2 Installation. Plastic diffusers shall be supported directly or indirectly from ceiling or roof construction by use of incombustible hangers. Hangers shall be at least No. 12 Steel Wire Gage [0.0106 inch (0.27 mm)] galvanized wire or equivalent.

2612.4.6.3 Size limitations. Individual panels or units shall not exceed 10 feet (3 m) in length or 30 square feet (2.8 m^2) in area.

2612.4.6.4 When buildings are protected by an automatic fire extinguishing system, this section shall apply to light diffusing systems within such buildings.

2612.4.6.4.1 Fire-extinguishing systems shall be located above and below the light diffusing system

TABLE 2612.4.4.4
AREA LIMITATIONS FOR ROOF PANELS

CLASS OF PLASTIC	MAX. SEPARATED PANEL AREA (SQ FT)	MAX. AGGREGATE AREA (% OF FLOOR AREA)
C1	300	30
C2	100	25

For SI: 1 square foot = 0.0929 m^2.

unless specifically approved for above such system only.

2612.4.6.4.2 Areas of light-diffusing systems protected by a fire-extinguishing system shall not have to comply with the size limitations set forth in this section.

2612.4.6.5 Electrical lighting fixtures.

2612.4.6.5.1 Plastic light-transmitting panels and light-diffuser panels installed in product approval electrical lighting fixtures shall have flame spread ratings compatible with the occupancy of the building.

2612.4.6.5.2 The area of approved plastic materials when used in required fire exits or corridors shall not exceed 30 percent of the aggregate area of the ceiling in which they are installed, unless the occupancy is protected by an approved fire extinguishing system.

2612.4.7 Partitions. Approved light-transmitting plastics may be used in or as partitions provided the requirement of the types of construction are met.

2612.4.8 Bathroom accessories. Approved plastics shall be permitted as glazing in shower stalls, shower doors, bathtub enclosures and similar accessory units and shall conform to 16 CFR 1205 and the *Safety Standard for Architectural Glazing Materials.*

2612.4.9 Awnings and similar structures. Approved lighttransmitting plastics may be used on or as awnings and similar structures when in conformance with provisions as set forth in other sections of this code.

CHAPTER 27

ELECTRICAL

SECTION 2701 GENERAL

2701.1 Scope. This chapter governs the electrical components, equipment and systems used in buildings and structures covered by this code. Electrical components, equipment and systems shall be designed and constructed in accordance with the provisions of NFPA 70, *National Electrical Code*, except Article 80.

[F] SECTION 2702 EMERGENCY AND STANDBY POWER SYSTEMS

2702.1 Installation. Emergency and standby power systems shall be installed in accordance with the NFPA 70, *National Electrical Code*, NFPA 110 and NFPA 111.

2702.1.1 Stationary generators. Reserved.

2702.2 Where required. Reserved.

2702.3 Maintenance. Reserved.

SECTION 2703 CROSS REFERENCES

2703.1 Cross references. See Table 2703.

SECTION 2704 BONDING METAL FRAMING MEMBERS

2704.1 Bonding metal framing members. Metal framing members shall be bonded to the equipment grounding conductor for the circuit that may energize the framing and be sized in accordance with the *National Electric Code* Table 250.122. For the purpose of this section, a grounded metal outlet box attached to the framing shall be permitted.

TABLE 2703
CROSS REFERENCES DEFINING ELECTRICAL REQUIREMENTS OF THE *FLORIDA BUILDING CODE*

Florida Building Code—Building			
Section		**Section**	
Chapter 1	Administration	Chapter 7	Fire-Resistance-Rated Construction
101	General	712	Penetrations
102	Applicability	714	Fire-Resistance Rating of Structural Members
105	Permits	715	Opening Protective
106	Construction Documents	716	Ducts and Air Transfer Openings
107	Temporary Structures and Uses		
108	Fees	Chapter 9	Fire Protection Systems
109	Inspections	901	General
111	Service Utilities	902	Definitions
		903	Automatic Sprinkler Systems
Chapter 2	Definitions	904	Alternative Automatic Fire-Extinguishing
202	Definitions		Systems
		907	Fire Alarm and Detection Systems
Chapter 3	Use and Occupancy Classification	908	Emergency Alarm Systems
302	Classification	909	Smoke Control Systems
306	Factory Group F	910	Smoke and Heat Vents
307	High -Hazard Group H	911	Fire Command Center
Chapter 4	Special Detailed Requirement	Chapter 10	Means of Egress
	Based on Use and Occupancy	1006	Means of Egress Illumination and Signs
402	Covered Mall Buildings	1008	Doors, Gates and Turnstiles
403	High-Rise Buildings	1033	Day Care
311	Storage Group S		

(continued)

TABLE 2703—continued
CROSS REFERENCES DEFINING ELECTRICAL REQUIREMENTS OF THE *FLORIDA BUILDING CODE*

Section		Section	
Chapter 4	Special Detailed Requirement	Chapter 11	Florida Accessibility Code For Building Construction
(continued)	Based on Use and Occupancy		Part A
404	Atriums	11-3	Miscellaneous Instructions and Definitions
405	Underground Buildings	11-4	Accessible Elements and Spaces: Scope
			and Technical Requirements
406	Motor-Vehicle-Related Occupancies	11-9	Accessible Transient Lodging
407	Group I-2		Part B
408	Group I-3	5	Guidelines
409	Motion Picture Projection Rooms		
412	Aircraft-Related Occupancies	Chapter 12	
414	Hazardous Materials	1205	Lighting
415	Groups H-1, H-2, H-3, H-4 and H-5		
419	Hospitals	Chapter 13	Energy Efficiency
420	Nursing Homes	13-101	Scope
421	Ambulatory Surgical Centers	Subchapter	
423	State Requirements for Educational	13-2	Definitions
	Facilities	13-3	Referenced Standards and Organizations
424	Swimming Pools and Bathing Places	13-4	Commercial Building Compliance Methods
	(Public and Private)	13-6	Residential Building Compliance Methods
425	Public Lodging Establishments		
426	Public Food Service Establishments	Appendix 13-B	Supplemental Information for Subchapter 13-4
427	Mental Health Programs		
428	Manufactured Buildings	Chapter 26	Plastic
431	Transient Public lodging Establishments	2606	Light-Transmitting Plastics
435	Control of Radiation Hazards	2611	Light-Transmitting Plastic Interior Signs
436	Day Care Occupancies	2612	High-Velocity Hurricane Zones—Plastics
		Chapter 27	Electrical
		2701	General
		2702	Emergency and Standby Power Systems
		Chapter 30	Elevators and Conveying Systems
		3003	Emergency Operations
		3005	Conveying Systems
		3006	Machine Rooms
		3011	Alterations to Electric and Hydraulic
			Elevators and Escalators
		Chapter 31	Special Construction
		3102	Membrane Structures
		3108	Radio and Television Towers
		3112	Lighting, Mirrors, Landscaping
		Chapter 33	
		3306	Protection of Pedestrians
		3310	Exits
		Chapter 35	Referenced Standards

(continued)

TABLE 2703—continued
Florida Building Code—Residential

Section		Section	
Chapter 3	Building Planning	Chapter 24	Fuel Gas
R303	Light, Ventilation and Heating	G2403 (202)	General Definitions
R313	Smoke Alarms	G2410 (309)	Electrical
R317	Dwelling Unit Separation	G2411 (310)	Electrical Bonding
		G2440 (615)	Sauna Heaters
Chapter 8	Roof -Ceiling Construction		
R808	Insulation Clearance	Chapter 33	General Requirements Electrical
		E3301	General Requirements Electrical
Chapter 13	General Mechanical System		
	Requirements	Chapter 43	Referenced Standards
M1303	Labeling of Equipment		
M1305	Appliance Access		

Florida Building Code—Existing

Section		**Section**	
Chapter 3	Classification of Work	Chapter 11	Relocated or Moved Buildings
305	Alterations-Level 3	1102	Requirements
Chapter 4	Repairs	Chapter 12	Compliance Alternatives
401	General	1201	General
408	Electrical		
		Chapter 14	Referenced Standards
Chapter 5	Alterations-Level 1		
508	Electrical	Appendix B	Standard for Rehabilitation
Chapter 6	Alterations-Level 2		
608	Electrical		
Chapter 8	Change of Occupancy		
808	Electrical		
811	Other Requirements		
Chapter 9	Additions		
901	General		
904	Smoke Alarms in Occupancy		
	Groups R-3 and R-4		

(continued)

TABLE 2703—continued
Florida Building Code—Mechanical

Section		Section	
Chapter 3	General Regulations	Chapter 9	Specific Appliances, Fireplaces and Solid Fuel-Burning Equipment
301	General	912	Infrared Radiant Heaters
306	Access and Service Space	917	Cooking Appliances
		918	Forced-Air Warm-Air Furnaces
Chapter 5	Exhaust Systems	924	Stationary Fuel Cell Power Plants
502	Required Systems	927	Residential Electric Duct Heaters
503	Motors and Fans	928	Vented Residential Floor Furnaces
504	Clothes Dryer Exhaust		
509	Fire Suppression Systems	Chapter 10	Boilers, Water Heaters and
513	Smoke Control Systems		Pressure Vessels
		1001	General
Chapter 6	Duct Systems	1004	Boilers
601	General	1006	Safety and Pressure Relief Valves
602	Plenums		And Controls
606	Smoke Detection System Control		
607	Ducts and Air Transfer Openings	Chapter 11	Refrigeration
		1104	System Application Requirements
Chapter 8	Chimneys and Vents	1105	Machinery Room, General Requirements
801	General	1106	Machinery Room, Special Requirements
804	Direct-Vent, Integral Vent and		
	Mechanical Draft System	Chapter 15	Referenced Standards

Florida Building Code—Plumbing

Section		Section	
Chapter 6	Water Supply and Distribution	Part II	Design Criteria
601	General	I.	Control Valves
612	Well Pumps and Tanks used for Private		
	Potable Water Systems	Part IV	Materials
		H.	Low Voltage Wiring
Chapter 11	Storm Drainage	I.	Irrigation Controllers
1113	Sumps and Pumping Systems	J.	Pumps and Wells
Chapter 13	Referenced Standards	Part V	Installation
		E.	Low Voltage Wire Installation
Appendix F	Proposed Construction Building Codes	F.	Hydraulic Control Tubing
	For Turf and Landscape Irrigation		
	Systems		

(continued)

TABLE 2703—continued
Florida Building Code—Fuel Gas

Section		Section	
Chapter 2	Definitions	Chapter 6	Specific Appliances
		627	Air Conditioning Equipment
Chapter 3	General Regulations	630	Infrared Radiant Heaters
306	Access and Service Space		
309	Electrical	Chapter 7	Gaseous Hydrogen Systems
310	Electrical Bonding	703	General Requirements
		706	Location of Gaseous Hydrogen Systems
Chapter 4	Gas Piping Installations		
413	Compressed Natural Gas Motor Vehicle	Chapter 8	Referenced Standards
	Fuel-Dispensing Stations		

This table is provided only as a tool to assist the construction industry as a general guide. Users should review all sections of the code in order to determine specific applicable electrical requirements.

CHAPTER 28

MECHANICAL SYSTEMS

SECTION 2801
GENERAL

2801.1 Scope. Mechanical appliances, equipment and systems shall be constructed, installed and maintained in accordance with the *Florida Building Code, Mechanical* and the *Florida Building Code, Fuel Gas*. Masonry chimneys, fireplaces and barbecues shall comply with the *Florida Building Code, Mechanical* and Chapter 21 of this code.

CHAPTER 29

PLUMBING SYSTEMS

SECTION 2901
GENERAL

2901.1 Scope. The provisions of this chapter and the *Florida Building Code, Plumbing* shall govern the erection, installation, alteration, repairs, relocation, replacement, addition to, use or maintenance of plumbing equipment and systems. Plumbing systems and equipment shall be constructed, installed and maintained in accordance with the *Florida Building Code, Plumbing.*

SECTION 2902
MINIMUM PLUMBING FACILITIES
RESERVED

CHAPTER 30
ELEVATORS AND CONVEYING SYSTEMS

SECTION 3001
GENERAL

3001.1 Scope. This chapter governs the design, construction, installation, alteration and repair of elevators and conveying systems and their components.

Note: Other administrative and programmatic provisions may apply. See the Department of Business and Professional Regulation [DBPR] Chapter 399, *Florida Statutes*, and 61C-5, *Florida Administrative Code*. The regulation and enforcement of the following sections of the adopted codes, and their addenda, are preempted to the Bureau of Elevator Safety of the Department of Business and Professional regulation: ASME A 17.1, Part 8, ASME A17.3, Sections 1.2, 1.5, ASME A 18.1, Part 10.

3001.2 Referenced standards. Except as otherwise provided for in this code, the design, construction, installation, alteration, repair and maintenance of elevators and conveying systems and their components shall conform to ASME A17.1, ASME A17.1S, ASME A90.1, ASME B20.1, ALI ALCTV, ASME A17.3 and ASME A18.1.

The Division of Hotels and Restaurants may grant exceptions, variances and waivers to the *Elevator Safety Code* as authorized by the *Elevator Safety Code (ASME A 17.1, Section 1.2) and Florida Statutes* (Chapter 120.)

3001.3 Accessibility. Passenger elevators required to be accessible by Chapter 11.

3001.4 Change in use. A change in use of an elevator from freight to passenger, passenger to freight, or from one freight class to another freight class shall comply with Part XII of ASME A17.1.

3001.5 Design, installation and alteration of elevators.

1. Each elevator shall comply with the *Elevator Safety Code* that was in effect at the time of receipt of application for the construction permit for the elevator.
2. Each alteration to, or relocation of, an elevator shall comply with the *Elevator Safety Code* that was in effect at the time of receipt of the application for the construction permit for the alteration or relocation.

3001.6 As used in this chapter, the term:

ALTERATION. Any change or addition to the vertical conveyance other than maintenance, repair or replacement.

CERTIFICATE OF OPERATION means a document issued by the department which indicates that the conveyance has had the required safety inspection and tests and that fees have been paid as provided in Chapter 399, FS.

CONVEYANCE. An elevator, dumbwaiter, escalator, moving sidewalk, platform lift and stairway chairlift.

DEPARTMENT. For the purpose of this section, means the Department of Business and Professional Regulation.

DIVISION. For the purpose of this section, means the Division of Hotels and Restaurants of the Department of Business and Professional Regulation.

ELEVATOR. One of the following mechanical devices:

(a) A hoisting and lowering mechanism, equipped with a car and platform that moves in guide rails and serves two or more landings to transport material or passengers or both.

(b) An escalator, which is a power-driven, inclined continuous stairway used for raising or lowering passengers.

(c) A dumbwaiter, which is a hoisting and lowering mechanism equipped with a car of limited size which moves in guide rails and serves two or more landings.

(d) A moving walk, which is a type of passenger-carrying device on which passengers stand or walk and in which the passenger-carrying surface remains parallel to its direction of motion and is uninterrupted.

(e) An inclined stairway chairlift, which is a device used to transport physically handicapped persons over architectural barriers.

(f) An inclined or vertical wheelchair lift, which is a device used to transport wheelchair handicapped persons over architectural barriers.

Exceptions:

Personnel hoists and material hoists within the scope of ASME A10.

Man lifts within the scope of ASME A90.1.

Mobile scaffolds, towers and platforms within the scope of ANSI A92.

Powered platforms and equipment for exterior and interior maintenance within the scope of ASME A120.1.

Conveyors and related equipment within the scope of ASME B20.1.

Cranes, derricks, hoists, hooks, jacks and slings within the scope of ASME B30.

Industrial trucks within the scope of ASME B56.

Portable equipment, except for portable escalators that are covered by this code.

Tiered or piling machines used to move materials to and from storage located and operating entirely within one story.

Equipment for feeding or positioning materials at machine tools and printing presses.

Skip or furnace hoists.

Wharf ramps.

Railroad car lifts or dumpers.

Line jacks, false cars, shafters, moving platforms and similar equipment used for installing an elevator by a contractor licensed in this state.

Automated people movers at airports.

Elevators in television and radio towers.

Hand-operated dumbwaiters.

Sewage pump station lifts.

Automobile parking lifts.

Equipment covered in Section 1.1.2 of the *Elevator Safety Code*.

Elevators, inclined stairway chairlifts and inclined or vertical wheelchair lifts located in private residences.

ESCALATOR. An installation defined as an escalator in the *Florida Building Code*.

EXISTING INSTALLATION. An installation defined as an "installation, existing" in the *Florida Building Code*.

PRIVATE RESIDENCE. A separate dwelling or a separate apartment in a multiple dwelling which is occupied by members of a single family.

SECTION 3002
HOISTWAY ENCLOSURES

3002.1 Hoistway enclosure protection. Elevator, dumbwaiter and other hoistway enclosures shall be shaft enclosures complying with Section 707.

3002.1.1 Opening protectives. Openings in hoistway enclosures shall be protected as required in Chapter 7.

Exception: The elevator car doors and the associated hoistway enclosure doors at the floor level designated for recall in accordance with Section 3003.2 shall be permitted to remain open during Phase I Emergency Recall Operation.

3002.1.2 Hardware. Hardware on opening protectives shall be of an approved type installed as tested, except that approved interlocks, mechanical locks and electric contacts, door and gate electric contacts and door-operating mechanisms shall be exempt from the fire test requirements.

3002.2 Number of elevator cars in a hoistway. Where four or more elevator cars serve all or the same portion of a building, the elevators shall be located in at least two separate hoistways. Not more than four elevator cars shall be located in any single hoistway enclosure.

3002.3 Emergency signs. An approved pictorial sign of a standardized design shall be posted adjacent to each elevator call station on all floors instructing occupants to use the exit stairways and not to use the elevators in case of fire. The sign shall read: IN FIRE EMERGENCY, DO NOT USE ELEVATOR. USE EXIT STAIRS. The emergency sign shall not be required for elevators that are part of an accessible means of egress complying with Section 1007.4.

3002.4 Elevator car to accommodate ambulance stretcher. Where elevators are provided in buildings four or more stories above grade plane or four or more stories below grade plane, at least one elevator shall be provided for fire department emergency access to all floors. The elevator car shall be of such a size and arrangement to accommodate a 24-inch by 84-inch (610 mm by 2250 mm) ambulance stretcher in the horizontal, open position and shall be identified by the international symbol for emergency medical services (star of life). The symbol shall not be less than 3 inches (76 mm) high and shall be placed inside on both sides of the hoistway door frame.

3002.5 Emergency doors. Where an elevator is installed in a single blind hoistway or on the outside of a building, there shall be installed in the blind portion of the hoistway or blank face of the building, an emergency door in accordance with ASME A17.1.

3002.6 Prohibited doors. Doors, other than hoistway doors and the elevator car door, shall be prohibited at the point of access to an elevator car unless such doors are readily openable from the car side without a key, tool, special knowledge or effort.

3002.7 Common enclosure with stairway. Elevators shall not be in a common shaft enclosure with a stairway.

3002.8 Glass in elevator enclosures. Glass in elevator enclosures shall comply with Section 2409.1.

3002.9 Automatic fire alarm-initiating devices shall be located and installed in accordance with ASME A17.1 and NFPA 72.

[F] SECTION 3003
EMERGENCY OPERATIONS

[F] 3003.1 Standby power. In buildings and structures where standby power is required or furnished to operate an elevator, the operation shall be in accordance with Sections 3003.1.1 through 3003.1.4.

[F] 3003.1.1 Manual transfer. Standby power shall be manually transferable to all elevators in each bank.

[F] 3003.1.2 One elevator. Where only one elevator is installed, the elevator shall automatically transfer to standby power within 60 seconds after failure of normal power.

[F] 3003.1.3 Two or more elevators. Where two or more elevators are controlled by a common operating system, all elevators shall automatically transfer to standby power within 60 seconds after failure of normal power where the standby power source is of sufficient capacity to operate all elevators at the same time. Where the standby power source is not of sufficient capacity to operate all elevators at the same time, all elevators shall transfer to standby power in sequence, return to the designated landing and disconnect from the standby power source. After all elevators have been returned to the designated level, at least one elevator shall remain operable from the standby power source.

[F] 3003.1.4 Venting. Where standby power is connected to elevators, the machine room ventilation or air conditioning shall be connected to the standby power source.

[F] 3003.2 Fire-fighters' emergency operation. Elevators shall be provided with Phase I emergency recall operation and Phase II emergency in-car operation in accordance with ASME A17.1.

SECTION 3004
HOISTWAY VENTING

3004.1 Vents required. Hoistways of elevators and dumbwaiters penetrating more than three stories shall be provided with a means for venting smoke and hot gases to the outer air in case of fire.

Exceptions:

1. In occupancies of other than Groups R-1, R-2, I-1, I-2 and similar occupancies with overnight sleeping quarters, venting of hoistways is not required where the building is equipped throughout with an approved automatic sprinkler system installed in accordance with Section 903.3.1.1 or 903.3.1.2.
2. Sidewalk elevator hoistways are not required to be vented.

3004.2 Location of vents. Vents shall be located at the top of the hoistway and shall open either directly to the outer air or through noncombustible ducts to the outer air. Noncombustible ducts shall be permitted to pass through the elevator machine room, provided that portions of the ducts located outside the hoistway or machine room are enclosed by construction having not less than the fire protection rating required for the hoistway. Holes in the machine room floors for the passage of ropes, cables or other moving elevator equipment shall be limited so as not to provide greater than 2 inches (51 mm) of clearance on all sides.

3004.3 Area of vents. Except as provided for in Section 3004.3.1, the area of the vents shall not be less than $3^1/_2$ percent of the area of the hoistway nor less than 3 square feet (0.28 m^2) for each elevator car, and not less than $3^1/_2$ percent nor less than 0.5 square feet (0.047 m^2) for each dumbwaiter car in the hoistway, whichever is greater. Of the total required vent area, not less than one-third shall be permanently open. Closed portions of the required vent area shall consist of openings glazed with annealed glass not greater than 0.125 inch (3.2 mm) in thickness.

Exception: The total required vent area shall not be required to be permanently open where all the vent openings automatically open upon detection of smoke in the elevator lobbies or hoistway, upon power failure and upon activation of a manual override control.

3004.3.1 Reduced vent area. Where mechanical ventilation conforming to the *Florida Building Code, Mechanical* is provided, a reduction in the required vent area is allowed provided that all of the following conditions are met:

1. The occupancy is not in Group R-1, R-2, I-1 or I-2 or of a similar occupancy with overnight sleeping quarters.
2. The vents required by Section 3004.2 do not have outside exposure.
3. The hoistway does not extend to the top of the building.
4. The hoistway and machine room exhaust fan is automatically reactivated by thermostatic means.
5. Equivalent venting of the hoistway is accomplished.

3004.4 Plumbing and mechanical systems. Plumbing and mechanical systems shall not be located in an elevator shaft.

Exception: Floor drains, sumps and sump pumps shall be permitted at the base of the shaft provided they are indirectly connected to the plumbing system.

SECTION 3005
CONVEYING SYSTEMS

3005.1 General. Escalators, moving walks, conveyors, personnel hoists and material hoists shall comply with the provisions of this section.

3005.2 Escalators and moving walks. Escalators and moving walks shall be constructed of approved noncombustible and fire-retardant materials. This requirement shall not apply to electrical equipment, wiring, wheels, handrails and the use of $^1/_{28}$-inch (0.9 mm) wood veneers on balustrades backed up with noncombustible materials.

3005.2.1 Enclosure. Escalator floor openings shall be enclosed with shaft enclosures complying with Section 707.

3005.2.2 Escalators. Where provided in below-grade transportation stations, escalators shall have a clear width of 32 inches (815 mm) minimum.

Exception: The clear width is not required in existing facilities undergoing alterations.

3005.3 Conveyors. Conveyors and conveying systems shall comply with ASME B20.1.

3005.3.1 Enclosure. Conveyors and related equipment connecting successive floors or levels shall be enclosed with shaft enclosures complying with Section 707.

3005.3.2 Conveyor safeties. Power-operated conveyors, belts and other material-moving devices shall be equipped with automatic limit switches which will shut off the power in an emergency and automatically stop all operation of the device.

3005.4 Personnel and material hoists. Personnel and material hoists shall be designed utilizing an approved method that accounts for the conditions imposed during the intended operation of the hoist device. The design shall include, but is not limited to, anticipated loads, structural stability, impact, vibration, and stresses. The design shall account for the construction, installation, operation and inspection of the hoist tower, car, machinery and control equipment, guide members and hoisting mechanism. Additionally, the design of personnel hoists shall include provisions for field testing and maintenance which will demonstrate that the hoist device functions in accordance with the design. Field tests shall be conducted upon the completion of an installation or following a major alteration of a personnel hoist.

SECTION 3006 MACHINE ROOMS

3006.1 Access. An approved means of access shall be provided to elevator machine rooms and overhead machinery spaces.

3006.2 Venting. Elevator machine rooms that contain solid-state equipment for elevator operation shall be provided with an independent ventilation or air-conditioning system to protect against the overheating of the electrical equipment. The system shall be capable of maintaining temperatures within the range established for the elevator equipment.

3006.3 Pressurization. The elevator machine room serving a pressurized elevator hoistway shall be pressurized upon activation of a heat or smoke detector located in the elevator machine room.

3006.4 Machine rooms and machinery spaces. Elevator machine rooms and machinery spaces shall be enclosed with fire barriers complying with Section 706 or horizontal assemblies complying with Section 711 having a fire-resistance rating not less than the required rating of the hoistway enclosure served by the machinery. Openings shall be protected with assemblies having a fire-protection rating not less than that required for the hoistway enclosure doors.

3006.5 Shunt trip. Where elevator hoistways or elevator machine rooms containing elevator control equipment are protected with automatic sprinklers, a means installed in accordance with NFPA 72, Section 3-9.4, Elevator Shutdown, shall be provided to disconnect automatically the main line power supply to the affected elevator prior to the application of water. This means shall not be self-resetting. The activation of sprinklers outside the hoistway or machine room shall not disconnect the main line power supply.

3006.6 Plumbing systems. Plumbing systems shall not be located in elevator equipment rooms.

SECTION 3007 ELEVATOR ACCESSIBILITY REQUIREMENTS FOR THE PHYSICALLY HANDICAPPED

3007.1 Each elevator must be made accessible to physically handicapped persons with the following requirements:

1. In a building having any elevators that do not provide access to every floor level, elevator hallway call buttons on all main levels of ingress and on any floor that is commonly served by more than one group of elevators must be marked with Arabic numerals and braille symbols that indicate floor levels to which access is provided. The symbols must be placed directly above each call button.
2. Each elevator car interior must have a support rail on at least one wall. All support rails must be smooth and have no sharp edges and must not be more than 1½ inches (38 mm) thick or 2½ inches (63 mm) in diameter. Support rails must be continuous and a minimum length of 42 inches (1067 mm) overall.

   The inside surface of support rails must be 1½ inches (38 mm) clear of the car wall. The distance from the top of the support rail to the finished car floor must be at least 31 inches (787 mm) and not more than 33 inches (838 mm). Padded or tufted material or decorative materials such as wallpaper, vinyl, cloth or the like may be not be used on support rails.
3. A bench or seat may be installed on the rear wall of the elevator car enclosure, if the bench or seat does not protrude beyond the vertical plane of the elevator car enclosure wall when folded into a recess provided for the bench or seat and, when not in use, the bench or seat automatically folds into the recess. The bench or seat must be capable of supporting a live load of at least 250 pounds (113.4 kg) on any 12-inch by 12-inch (305 mm by 305 mm) area. A padded, tufted or other decorative material may not be used to cover the bench or seat; nor may the bench or seat encroach on the minimum clear inside-car dimensions specified in this section.

This section applies only to elevators available for the transportation of the public. This section does not apply to elevators restricted by key or similar device to a limited number of persons in a building that has an elevator that otherwise meets the requirements of this section or to elevators used only for the transportation of freight. However, elevators that are used as freight and passenger elevators for the public and employees must comply with this section. This section does not apply to dumbwaiters or escalators.

This section supersedes all other state regulations and local ordinances and rules affecting the accessibility of passenger elevators to the physically handicapped, and the standards established by this section may not be modified by municipal or county ordinance.

SECTION 3008 SERIAL NUMBERS

3008.1 Serial numbers. Each elevator shall have a serial number assigned by the division painted on or attached to the elevator car in plain view and also to the driving mechanism. This serial number shall be shown on all required certificates and permits.

1. Certificates of operation must be posted in a conspicuous location in the elevator and shall contain the text of Section 823.12, *Florida Statutes* relating to the prohibition against smoking in elevators. The certificate must be framed with a transparent cover.
2. In addition to Item 3, the designation "NO SMOKING" along with the international symbol for no smoking shall be conspicuously displayed within the interior of the elevator in the plain view of the public.
3. The following rules of ASME A17.1, are hereby amended to read as follows:
   a. Rule 2.29.1 is to have the following sentence added at the end of this rule: Each car in a multi-car group shall be sequentially identified from left to right, as viewed from the elevator lobby.

b. Rule 2.7.3.1 of ASME A17.1, which is amended to read as follows: "Rule 2.7.3.1 General Requirements. A permanent, safe and convenient means of access to elevator machine rooms and overhead machinery spaces shall be provided for authorized persons. The key to the machine rooms and overhead machinery spaces shall be kept on the premises at all times and readily available for use by State of Florida certified Elevator Inspectors."

c. Rule 2.27.8, Switch Keys, of ASME A17.1, is amended to read as follows: "The switches required by Rule 211.2 through 211.5, for all elevators in a building, must be operable by the same keys. This key must not be part of a building master key system. There must be a key for the designated level switch and for each elevator in the group. These keys must be kept on the premises at all times in a location readily accessible to authorized personnel, and state elevator inspectors, but not where the key is available to the general public. NOTE: (RULE 2.27.8): Local authorities may specify a uniform keyed lock box to contain the necessary keys."

d. Rule 6.1.6.1, Starting Switch, of ASME A17.1, is amended to read as follows: "Starting switches must be of the key-operated type and must be located so that the escalator steps are within sight. Automatic starting by any means is prohibited. The key for the starting switches must be kept on the premises at all times in a location readily available to authorized personnel and state elevator inspectors, but not where the key is available to the general public."

e. Rule 2.2.2.4 Drains connected directly to sewers shall not be installed in elevator pits. Where drains are not provided to prevent the accumulation of water, a sump of adequate size and depth to accommodate a pump shall be provided, with or without a pump.

SECTION 3009
ELECTROLYSIS PROTECTION FOR UNDERGROUND HYDRAULIC ELEVATOR CYLINDERS

3009.1 Electrolysis protection for underground hydraulic elevator cylinders. All newly installed underground hydraulic pressure cylinders shall be encased in outer plastic containment to minimize electrolytic corrosion between the metal cylinder and ground cathode.

1. The plastic casing shall be capped at the bottom, and all joints must be solvent or heat welded to ensure water tightness.
2. The plastic casing shall be constructed of polyethylene or polyvinyl chloride (PVC). The plastic pipe wall thickness must not be less than 0.125 inch (3.175 mm).
3. The neck of the plastic casing shall have a means of inspection provided to monitor the annulus between the pressurized hydraulic cylinder and the protective plastic casing.
4. Replacements of existing hydraulic cylinders shall be protected by the aforementioned method where existing physical dimensions permit.

SECTION 3010
BULLETIN BOARDS

3010.1 Bulletin boards.

1. Bulletin boards and frames used in elevator cars shall not create any conditions which will be unsafe for users of the elevator car. Users shall include:

   A. Disabled persons;

   B. Persons confined to wheelchairs; and

   C. All other persons who may operate the elevator car in its normal course of use.
2. Bulletin boards shall not protrude more than 1 inch (25.4 mm) beyond the vertical line of the car wall. They shall not encroach on any clearances required to be maintained in the elevator by Chapter 399, *Florida Statutes*, and ASME A17.1.
3. Bulletin boards shall be framed and all edges must be smooth and rounded. No sharp edges of any kind shall protrude.
4. A glass or plastic cover shall be provided. Glass, if used, must meet the following requirements:

   A. Be laminated;

   B. Meet the requirement for laminated glass as set forth in ANSI Z97.1;

   C. The cover shall be securely held in place by the frame.
5. The frame and bulletin board shall be permanently fastened to the car wall in such a manner that all parts including the cover in place will withstand any and all tests required of the elevator.
6. All materials used shall be fire resistive equal to the requirements of the cab enclosure.
7. The bottom of the bulletin boards shall not be less than 5 feet (1524 mm) above the cab floor, and the total area shall not exceed 4 square feet (0.37 m^2).

SECTION 3011
ALTERATIONS TO ELECTRIC AND HYDRAULIC ELEVATORS AND ESCALATORS

3011.1 Alterations to electric and hydraulic elevators and escalators.

1. In addition to the alterations set forth in Rule 8.10.3.3.2 and Rule 8.10.2.3.2 ASME A17.1, the following alterations require, in addition to a construction permit, that inspections and tests be performed to determine conformance with ASME A17.1, rules cited below:

ALTERATIONS	Electric Elevators	Hydraulic Elevators
(a) Addition of elevator to existing hoistway (new installation)	8.7.2.1.2	8.7.2.1.2
(b) Brake (replacements of existing drive, machine brake by a new brake)	2.24	—
(c) Buffer (addition of oil buffer)	9.7.2.23	8.7.2.27
(d) Driving machine (replacement of)	8.7.2.25.1	8.7.3.23
(e) Freight elevator converted to passenger service	8.7.2.16.1	8.7.3.27
(f) Rope, replacement in size or number of ropes	8.6.2.5	8.6.2.5
(g) Sheave, driving machine (replacement in size)	8.7.2.25.1	8.7.2.25.1

2. The following alterations require, in addition to a construction permit, that inspections be performed to determine conformance with ASME A17.1, rule cited below:

ALTERATIONS	Electric Elevators	Hydraulic Elevators
(a) Access Switch (addition of)	8.7.2.11.4, 8.7.7.2	8.7.3.11, 8.7.7.2
(b) Automatic transfer device (addition of)		8.7.3.13
(c) Car, door or gate (addition of car door or gate electric contacts)	8.7.2.14	
(d) Car enclosure	8.7.2.14	8.7.3.13
(e) Car leveling device (addition of) and (trucking device)	8.7.2.27.2	8.7.3.31.2
(f) Control	8.7.2.27.5	8.7.3.31.6
(g) Control equipment	8.7.2.27	8.7.3.31
(h) Controller (existing controller w/new) (excluding dispatching device)	8.7.2.27.4	8.7.3.31.5
(i) Counterweight (change of)	8.7.3.23	8.7.3.26
(j) Increase in travel (or decrease)	8.7.2.17.1	8.7.3.22.1
(k) Door, hoistway (replacement of all hoistway doors)	8.7.2.10	8.7.3.10
(l) Escalator, relocation of	8.7.6.1	—
(m) Escalator, skirt (switches addition of safety device)	6.1.6	—
(n) Freight elevator permitted to carry passengers	8.7.2.16.3	8.7.3.19
(o) Guide rails (change in type or size)	8.7.2.24	8.7.3.28
(p) Hoistway door, power operation of (addition of)	8.7.2.12	8.7.3.12
(q) Hoistway door locking device (addition of)	8.7.2.11	8.7.3.11
(r) Operation, change in type of	8.7.2.27.6	8.7.3.31.7
(s) Platform, car (complete replacement of)	8.7.2.15.1	8.7.3.14
(t) Roller guide shoe, counter-weight and car (addition of)	8.7.2.22	8.7.2.22
(u) Rope equalizer (addition of)	8.7.2.21.2	8.7.3.25.2
(v) Rope fastening device, auxiliary (addition of)	8.7.2.21.3	8.7.2.21.3
(w) Tank (replacement of) (with different capacity)	—	8.7.3.29
(x) Top of car operating device (addition of)	8.7.2.27.1	8.7.3.31.1

CHAPTER 31
SPECIAL CONSTRUCTION

SECTION 3101
GENERAL

3101.1 Scope. The provisions of this chapter shall govern special building construction including membrane structures, temporary structures, pedestrian walkways and tunnels, awnings and canopies, marquees, signs, and towers and antennas.

SECTION 3102
MEMBRANE STRUCTURES

3102.1 General. The provisions of this section shall apply to air-supported, air-inflated, membrane-covered cable and membrane-covered frame structures, collectively known as membrane structures, erected for a period of 180 days or longer. Those erected for a shorter period of time shall comply with the *Florida Fire Prevention Code.* Membrane structures covering water storage facilities, water clarifiers, water treatment plants, sewage treatment plants, greenhouses and similar facilities not used for human occupancy, are required to meet only the requirements of Sections 3102.3.1 and 3102.7.

3102.2 Definitions. The following words and terms shall, for the purposes of this section and as used elsewhere in this code, have the meanings shown herein:

AIR-INFLATED STRUCTURE. A building where the shape of the structure is maintained by air pressurization of cells or tubes to form a barrel vault over the usable area. Occupants of such a structure do not occupy the pressurized area used to support the structure.

AIR-SUPPORTED STRUCTURE. A building wherein the shape of the structure is attained by air pressure and occupants of the structure are within the elevated pressure area. Air-supported structures are of two basic types:

> **Double skin.** Similar to a single skin, but with an attached liner that is separated from the outer skin and provides an airspace which serves for insulation, acoustic, aesthetic or similar purposes.
>
> **Single skin.** Where there is only the single outer skin and the air pressure is directly against that skin.

CABLE-RESTRAINED, AIR-SUPPORTED STRUCTURE. A structure in which the uplift is resisted by cables or webbings which are anchored to either foundations or dead men. Reinforcing cable or webbing is attached by various methods to the membrane or is an integral part of the membrane. This is not a cable-supported structure.

MEMBRANE-COVERED CABLE STRUCTURE. A nonpressurized structure in which a mast and cable system provides support and tension to the membrane weather barrier and the membrane imparts stability to the structure.

MEMBRANE-COVERED FRAME STRUCTURE. A nonpressurized building wherein the structure is composed of a rigid framework to support a tensioned membrane which provides the weather barrier.

NONCOMBUSTIBLE MEMBRANE STRUCTURE. A membrane structure in which the membrane and all component parts of the structure are noncombustible.

3102.3 Type of construction. Noncombustible membrane structures shall be classified as Type IIB construction. Noncombustible frame or cable-supported structures covered by an approved membrane in accordance with Section 3102.3.1 shall be classified as Type IIB construction. Heavy timber frame-supported structures covered by an approved membrane in accordance with Section 3102.3.1 shall be classified as Type IV construction. Other membrane structures shall be classified as Type V construction.

> **Exception:** Plastic less than 30 feet (9144 mm) above any floor used in greenhouses, where occupancy by the general public is not authorized, and for aquaculture pond covers is not required to meet the fire propagation performance criteria of NFPA 701.

3102.3.1 Membrane and interior liner material. Membranes and interior liners shall be either noncombustible as set forth in Section 703.4 or meet the fire propagation performance criteria of NFPA 701 and the manufacturer's test protocol.

> **Exception:** Plastic less than 20 mil (0.5 mm) in thickness used in greenhouses, where occupancy by the general public is not authorized, and for aquaculture pond covers is not required to meet the fire propagation performance criteria of NFPA 701.

3102.4 Allowable floor areas. The area of a membrane structure shall not exceed the limitations set forth in Table 503, except as provided in Section 506.

3102.5 Maximum height. Membrane structures shall not exceed one story nor shall such structures exceed the height limitations in feet set forth in Table 503.

> **Exception:** Noncombustible membrane structures serving as roofs only.

3102.6 Mixed construction. Membrane structures shall be permitted to be utilized as specified in this section as a portion of buildings of other types of construction. Height and area limits shall be as specified for the type of construction and occupancy of the building.

3102.6.1 Noncombustible membrane. A noncombustible membrane shall be permitted for use as the roof or as a skylight of any building or atrium of a building of any type of construction provided it is at least 20 feet (6096 mm) above any floor, balcony or gallery.

3102.6.1.1 Membrane. A membrane meeting the fire propagation performance criteria of NFPA 701 shall be permitted to be used as the roof or as a skylight on buildings of Type IIB, III, IV and V construction, provided it is at least 20 feet (6096 mm) above any floor, balcony or gallery.

3102.7 Engineering design. The structure shall be designed and constructed to sustain dead loads; loads due to tension or inflation; live loads including wind loads in accordance with Chapter 16.

3102.8 Inflation systems. Air-supported and air-inflated structures shall be provided with primary and auxiliary inflation systems to meet the minimum requirements of Sections 3102.8.1 through 3102.8.3.

3102.8.1 Equipment requirements. This inflation system shall consist of one or more blowers and shall include provisions for automatic control to maintain the required inflation pressures. The system shall be so designed as to prevent overpressurization of the system.

3102.8.1.1 Auxiliary inflation system. In addition to the primary inflation system, in buildings exceeding 1,500 square feet (140 m^2) in area, an auxiliary inflation system shall be provided with sufficient capacity to maintain the inflation of the structure in case of primary system failure. The auxiliary inflation system shall operate automatically when there is a loss of internal pressure and when the primary blower system becomes inoperative.

3102.8.1.2 Blower equipment. Blower equipment shall meet the following requirements:

1. Blowers shall be powered by continuous-rated motors at the maximum power required for any flow condition as required by the structural design.
2. Blowers shall be provided with inlet screens, belt guards and other protective devices as required by the building official to provide protection from injury.
3. Blowers shall be housed within a weather-protecting structure.
4. Blowers shall be equipped with backdraft check dampers to minimize air loss when inoperative.
5. Blower inlets shall be located to provide protection from air contamination. The location of inlets shall be approved.

3102.8.2 Standby power. Wherever an auxiliary inflation system is required, an approved standby power-generating system shall be provided. The system shall be equipped with a suitable means for automatically starting the generator set upon failure of the normal electrical service and for automatic transfer and operation of all of the required electrical functions at full power within 60 seconds of such service failure. Standby power shall be capable of operating independently for a minimum of 4 hours.

3102.8.3 Support provisions. A system capable of supporting the membrane in the event of deflation shall be provided for in air-supported and air-inflated structures having an occupant load of 50 or more or where covering a swimming pool regardless of occupant load. The support system shall be capable of maintaining membrane structures used as a roof for Type I construction not less than 20 feet (6096 mm) above floor or seating areas. The support system shall be capable of maintaining other membranes at least 7 feet (2134 mm) above the floor, seating area or surface of the water.

SECTION 3103
TEMPORARY STRUCTURES

3103.1 General. The provisions of this section shall apply to structures erected for a period of less than 180 days. Tents and other membrane structures erected for a period of less than 180 days shall comply with the *Florida Fire Prevention Code*. Those erected for a longer period of time shall comply with applicable sections of this code.

Exception: Provisions of the *Florida Fire Prevention Code* shall apply to tents and membrane structures erected for a period of less than 180 days.

3103.1.1 Permit required. Temporary structures that cover an area in excess of 120 square feet (11.16 m^2), including connecting areas or spaces with a common means of egress or entrance which are used or intended to be used for the gathering together of 10 or more persons, shall not be erected, operated or maintained for any purpose without obtaining a permit from the building official.

3103.2 Construction documents. A permit application and construction documents shall be submitted for each installation of a temporary structure. The construction documents shall include a site plan indicating the location of the temporary structure and information delineating the means of egress and the occupant load.

3103.3 Location. Temporary structures shall be located in accordance with the requirements of Table 602 based on the fire-resistance rating of the exterior walls for the proposed type of construction.

3103.4 Means of egress. Temporary structures shall conform to the means of egress requirements of Chapter 10 and shall have a maximum exit access travel distance of 100 feet (30 480 mm).

SECTION 3104
PEDESTRIAN WALKWAYS AND TUNNELS

3104.1 General. This section shall apply to connections between buildings such as pedestrian walkways or tunnels, located at, above or below grade level, that are used as a means of travel by persons. The pedestrian walkway shall not contribute to the building area or the number of stories or height of connected buildings.

3104.2 Separate structures. Connected buildings shall be considered to be separate structures.

Exceptions:

1. Buildings on the same lot in accordance with Section 503.1.2.
2. For purposes of calculating the number of Type B units required by Chapter 11, structurally connected

buildings and buildings with multiple wings shall be considered one structure.

3104.3 Construction. The pedestrian walkway shall be of noncombustible construction.

Exceptions:

1. Combustible construction shall be permitted where connected buildings are of combustible construction.
2. Fire-retardant-treated wood, in accordance with Section 603.1, Item 1.3, shall be permitted for the roof construction of the pedestrian walkway where connected buildings are a minimum of Type I or II construction.

3104.4 Contents. Only materials and decorations approved by the building official shall be located in the pedestrian walkway.

3104.5 Fire barriers between pedestrian walkways and buildings. Walkways shall be separated from the interior of the building by fire-barrier walls with a fire-resistance rating of not less than 2 hours. This protection shall extend vertically from a point 10 feet (3048 mm) above the walkway roof surface or the connected building roof line, whichever is lower, down to a point 10 feet (3048 mm) below the walkway and horizontally 10 feet (3048 mm) from each side of the pedestrian walkway. Openings within the l0-foot (3048 mm) horizontal extension of the protected walls beyond the walkway shall be equipped with devices providing a $^3/_4$-hour fire protection rating in accordance with Section 715.

Exception: The walls separating the pedestrian walkway from a connected building are not required to have a fire-resistance rating by this section where any of the following conditions exist:

1. The distance between the connected buildings is more than 10 feet (3048 mm), the pedestrian walkway and connected buildings, except for open parking garages, are equipped throughout with an automatic sprinkler system in accordance with NFPA 13 and the wall is constructed of a tempered, wired or laminated glass wall and doors subject to the following:
   - 1.1. The glass shall be protected by an automatic sprinkler system in accordance with NFPA 13 and the sprinkler system shall completely wet the entire surface of interior sides of the glass wall when actuated.
   - 1.2. The glass shall be in a gasketed frame and installed in such a manner that the framing system will deflect without breaking (loading) the glass before the sprinkler operates.
   - 1.3. Obstructions shall not be installed between the sprinkler heads and the glass.
2. The distance between the connected buildings is more than 10 feet (3048 mm) and both sidewalls of the pedestrian walkway are at least 50 percent open with the open area uniformly distributed to prevent the accumulation of smoke and toxic gases.
3. Buildings are on the same lot in accordance with Section 503.1.2.
4. Where exterior walls of connected buildings are required by Section 704 to have a fire-resistance rating greater than 2 hours, the walkway shall be equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13.

The previous exceptions shall apply to the pedestrian walkways that have a maximum height above grade of three stories or 40 feet (12 192 mm), or five stories or 55 feet (16 764 mm) where sprinklered.

3104.6 Public way. Pedestrian walkways over a public way shall also comply with Chapter 32.

3104.7 Egress. Access shall be provided at all times to a pedestrian walkway that serves as a required exit.

3104.8 Width. The unobstructed width of pedestrian walkways shall not be less than 36 inches (914 mm). The total width shall not exceed 30 feet (9144 mm).

3104.9 Exit access travel. The length of exit access travel shall not exceed 200 feet (60 960 mm).

Exceptions:

1. Exit access travel distance on a pedestrian walkway equipped throughout with an automatic sprinkler system in accordance with NFPA 13 shall not exceed 250 feet (76 200 mm).
2. Exit access travel distance on a pedestrian walkway constructed with both sides at least 50 percent open shall not exceed 300 feet (91 440 mm).
3. Exit access travel distance on a pedestrian walkway constructed with both sides at least 50 percent open, and equipped throughout with an automatic sprinkler system in accordance with NFPA 13, shall not exceed 400 feet (122 m).

3104.10 Tunneled walkway. Separation between the tunneled walkway and the building to which it is connected shall not be less than 2-hour fire-resistant construction and openings therein shall be protected in accordance with Table 715.4.

SECTION 3105
AWNINGS AND CANOPIES

3105.1 Fabric awnings and fabric-covered frames. Fabric awnings and fabric-covered frames shall comply with the provisions of Section 3105 as applicable.

3105.1.1 Location.

3105.1.1.1 Fabric awnings and fabric-covered frames located over public property or in areas accessible to the general public shall be constructed so that no rigid part of such fabric awnings or fabric-covered frames shall be less than 7 feet, 6 inches (2286 mm) from the grade directly below, and no part of the cloth drop shall be less than 7 feet (2134 mm).

3105.1.1.2 A fixed fabric awning or fabric-covered frame shall not extend over public property more than two-thirds the distance from the property line to the nearest curb line in front of the building site as measured from the exterior face of the building nor shall any portion be closer than 18 inches (457 mm) to the curb line.

Exceptions:

1. If installed over 14 feet (4267 mm) in height, it may occupy the entire width of the sidewalk.
2. Unless otherwise regulated by local zoning requirements.

3105.1.1.3 Fabric-covered framework in whole or in part of fabric, erected in connection with gasoline service stations may not be erected within 15 feet (4572 mm) of where flammable liquids are transferred.

3105.1.1.4 Movable fabric awnings or fabric covered frames may extend over public property for a distance of not more than 5 feet (1524 mm), provided such awnings or any part thereof maintain a clear height of 8 feet (2438 mm) above the sidewalk. All such movable awnings shall be supported on metal frames attached to the building.

3105.1.1.5 Every fabric awning or fabric-covered frame shall be located not to interfere with the operation of any exterior standpipe, stairway, fire escape or any means of egress to and from the building.

3105.2 Area. No fabric awning or fabric-covered frame shall exceed the area of the building to which it is attached.

3105.3 Material.

3105.3.1 Fabric used for awnings or fabric-covered frames shall be flame resistant in accordance with NFPA 701.

Exception: Awnings or fabric-covered frames used in conjunction with Group R-3 occupancies.

3105.3.2 Supports for fabric awnings and fabric-covered frame shall be of metal or similar durable material.

3105.4 Design.

3105.4.1 Design of the framing members shall not be based on removal or repositioning of parts, or the whole, during periods of 75 mph wind velocity.

3105.4.2 Design of the structural framing members shall be based on rational analysis, using the applicable wind loads of Chapter 16 as shown below:

3105.4.2.1 The wind design loads for any fabric or membrane-covered structure designed with a quick removal or breakaway membrane or fabric at wind velocities of 75 mph, shall be based on the following criteria:

1. Minimum wind velocity of 3-second wind gust 90 mph
2. Importance factor based on low hazard to human life of 0.77.
3. Exposure Category B for or C as defined in Chapter 16.

3105.4.2.2 The wind design loads for any fabric or membrane covered structure designed with a permanent or nonremovable fabric or membrane, shall be based on the following criteria:

1. Minimum wind velocity as required in Chapter 16.
2. Importance factor based on low hazard to human life of 0.77.
3. Exposure Category B or C as defined in Chapter 16.

3105.4.3 The fabric portions of awnings fabric covered frames shall be securely laced, tied or otherwise fastened to the frame; no rafter or front bar will be permitted in pockets; and in no case shall a rolling curtain be caused to operate over a canopy frame.

3105.4.4 The horizontal projection of cantilevered portions shall not be greater than two times the height, except where the building construction does not permit a proper installation; in which case, variance may be permitted by the building official, based on special design and construction.

3105.5 Rigid awnings and canopy shutters.

3105.5.1 Loads. Rigid awnings and canopy shutters shall be designed to resist the loads set forth in Chapter 16 of this Code except that structures or parts thereof which are intended to be removed or repositioned during periods of high wind velocity shall be designed in their open or extended position to design pressures based on a basic wind speed of minimum 90 mph, 3-second wind gust with applicable shape factors and to resist not less than 10 psf (478 Pa) roof live load.

3105.5.2 Where such structure is intended to be folded or otherwise repositioned to close an opening when the building is unattended or act as a storm shutter, the design in the closed position shall also comply with Chapter 16 and shall be impact resistant in accordance with Section1609.1.4.

3105.5.3 Structures designed to be readily removed or repositioned during periods of high wind velocity shall be posted with a legible and readily visible decal or painted instructions to the owner or tenant to remove or reposition the structure or part thereof during such periods of time as are designated by the U.S. Weather Bureau as being a hurricane warning or alert.

SECTION 3106
MARQUEES

3106.1 General. Marquees shall comply with this section and other applicable sections of this code.

3106.2 Thickness. The maximum height or thickness of a marquee measured vertically from its lowest to its highest point shall not exceed 3 feet (914 mm) where the marquee projects more than two-thirds of the distance from the property line to the curb line, and shall not exceed 9 feet (2743 mm) where the marquee is less than two-thirds of the distance from the property line to the curb line.

3106.3 Roof construction. Where the roof or any part thereof is a skylight, the skylight shall comply with the requirements of Chapter 24. Every roof and skylight of a marquee shall be sloped to downspouts that shall conduct any drainage from the marquee in such a manner so as not to spill over the sidewalk.

3106.4 Location prohibited. Every marquee shall be so located as not to interfere with the operation of any exterior standpipe, and such that the marquee does not obstruct the clear passage of stairways or exit discharge from the building or the installation or maintenance of street lighting.

3106.5 Construction. A marquee shall be supported entirely from the building and constructed of noncombustible materials. Marquees shall be designed as required in Chapter 16. Structural members shall be protected to prevent deterioration.

SECTION 3107
SIGNS

3107.1 General. Signs shall be designed, constructed and maintained in accordance with this code.

SECTION 3108
RADIO AND TELEVISION TOWERS

3108.1 General. Subject to the provisions of Chapter 16 and the requirements of Chapter 15 governing the fire-resistance ratings of buildings for the support of roof structures, radio and television towers shall be designed and constructed as herein provided.

3108.2 Location and access. Towers shall be located and equipped with step bolts and ladders so as to provide ready access for inspection purposes. Guy wires or other accessories shall not cross or encroach upon any street or other public space, or over above-ground electric utility lines, or encroach upon any privately owned property without written consent of the owner of the encroached-upon property, space or above-ground electric utility lines.

3108.3 Construction. Towers shall be constructed of approved corrosion-resistant noncombustible material. The minimum type of construction of isolated radio towers not more than 100 feet (30 480 mm) in height shall be Type IIB.

3108.4 Loads. Towers shall be designed to resist wind loads in accordance with TIA/EIA-222. Consideration shall be given to conditions involving wind load on ice-covered sections in localities subject to sustained freezing temperatures.

3108.4.1 Dead load. Towers shall be designed for the dead load plus the ice load in regions where ice formation occurs.

3108.4.2 Wind load. Adequate foundations and anchorage shall be provided to resist two times the calculated wind load.

3108.5 Grounding. Towers shall be permanently and effectively grounded.

SECTION 3109
STRUCTURES SEAWARD OF A COASTAL CONSTRUCTION CONTROL LINE

3109.1 General.

3109.1.1 Scope. The provisions of Section 3109 shall ensure that structures located seaward of the coastal construction control line are designed to resist the predicted forces associated with a 100-year storm event and shall apply to the following:

1. All habitable structures which extend wholly or partially seaward of a coastal construction control line (CCCL) or 50-foot (15.3 m) setback line.
2. Substantial improvement of or additions to existing habitable structures.
3. Swimming pools that are located in close proximity to a habitable structure or armoring. An environmental permit from the Florida Department of Environmental Protection, requiring special siting considerations to protect the beach-dune system or proposed or existing structures and public beach access, is required prior to the start of construction. The environmental permit may condition the nature, timing and sequence of construction of permitted activities to provide protection to nesting sea turtles and hatchlings and their habitat, including review, submittal and approval of lighting plans.

Exception: The standards for buildings seaward of a CCCL area do not apply to any modification, maintenance or repair to any existing structure within the limits of the existing foundation which does not require, involve or include any additions to, or repair or modification of, the existing foundation of that structure.

3109.1.2 Certification. As part of the permit process and upon placement of the lowest horizontal structural member, the applicant shall submit to the building official certification of the elevation of the lowest horizontal structural member of the lowest floor as built in relation to National Geodetic Vertical Datum (N.G.V.D.). Said certification shall be prepared by or under the direct supervision of a registered land surveyor or professional engineer or architect and certified by same and be submitted prior to commencing any addition work. Any work undertaken prior to submission of the certification shall be at the applicant's risk. The building official shall review the submitted elevation data, and any deficiencies found shall be corrected by the permit holder immediately and prior to any further work being permitted to proceed.

3109.2 Definitions.

ARMORING. A manmade structure designed to either prevent erosion of the upland property or protect upland structures from the effects of coastal wave and current action. Armoring includes certain rigid coastal structures such as geotextile bags or tubes, seawalls, revetments, bulkheads, retaining walls or similar structures, but does not include jetties, groins or other construction whose purpose is to add sand to the beach and dune system, alter the natural coastal currents or stabilize the mouths of inlets.

BREAKAWAY WALL. A partition independent of supporting structural members that is intended to withstand design wind forces but to collapse from a water load less than that which would occur during a 100-year storm event without causing collapse, displacement or other structural damage to the elevated portion of the building or supporting foundation system.

COASTAL CONSTRUCTION CONTROL LINE. The line established by the State of Florida pursuant to Section161.053, *Florida Statutes*, and recorded in the official records of the county which defines that portion of the beach-dune system subject to severe fluctuations based on a 100-year storm surge, storm waves or other predictable weather conditions.

DESIGN GRADE. The predicted eroded grade caused by the 100-year storm.

FIFTY-FOOT SETBACK LINE. A line of jurisdiction, established pursuant to the provisions of Section 161.052, *Florida Statutes*, in which construction is prohibited within 50 feet (15.13 m) of the line of mean high water at any riparian coastal location fronting the Gulf of Mexico or the Atlantic coast shoreline.

HABITABLE STRUCTURE. Structures designed primarily for human occupancy and are potential locations for shelter from storms. Typically included within this category are residences, hotels and restaurants.

LOWEST HORIZONTAL STRUCTURE MEMBER. Any shore-parallel structural member which supports floor, wall or column loads and transmits them to the pile foundation.

ONE-HUNDRED-YEAR STORM ELEVATION. The height of the breaking wave crest or wave approach as superimposed on the storm surge with dynamic wave setup of a 100-year storm. This 100-year storm elevation is determined by the Florida Department of Environmental Protection based on studies published as part of the coastal construction control line establishment process and an analysis of topographic and other site specific data.

REBUILDING. See definition of "Substantial improvement."

SUBSTANTIAL IMPROVEMENT. See definition in Section 161.54(12), *Florida Statutes*.

3109.3 Elevation standards. All habitable structures shall be elevated at or above an elevation which places the lowest horizontal structural member above the 100-year storm elevation as determined by the Florida Department of Environmental Protection in the report titled "One-Hundred-Year Storm Elevation Requirements for Habitable Structures Located Seaward of a Coastal Construction Control Line."

An applicant may request the Department of Environmental Protection to determine a site-specific 100-year storm elevation for the applicant's proposed habitable structure as part of the environmental permit application process. The elevation will be provided as part of the applicant's environmental permit and shall be subject to review under the provisions of Chapter 120, *Florida Statutes*.

Exceptions:

1. Additions, repairs or modifications to existing nonconforming habitable structures that do not advance the seaward limits of the existing habitable structure and do not constitute rebuilding of the existing structure.
2. Habitable structures located landward of existing armoring which is capable of protecting buildings from the effects of erosion from a 100-year storm surge. The applicant shall provide scientific and engineering evidence that the armoring has been designed, constructed and maintained to survive the effects of the design storm and provide protection to existing and proposed structures from the erosion associated with that event. Evidence shall include a report with data and supporting analysis, and shall be certified by a professional engineer registered in this state, that the armoring was designed and constructed and is in adequate condition to meet the following criteria:
   - 2.1. The top must be at or above the still water level, including setup, for the design storm plus the breaking wave calculated at its highest achievable level based on the maximum eroded beach profile and highest surge level combination, and must be high enough to preclude runup overtopping.
   - 2.2. The armoring must be stable under the design storm including maximum localized scour, with adequate penetration and toe protection to avoid settlement, toe failure, or loss of material from beneath or behind the armoring.
   - 2.3. The armoring must have sufficient continuity or return walls to prevent flanking under the design storm from impacting the proposed construction.
   - 2.4. The armoring must withstand the static and hydrodynamic forces of the design storm.
3. A higher elevation standard is required by either the National Flood Insurance Program (NFIP), as found on a community's Flood Insurance Rate Map (FIRM), or the local flood damage prevention ordinance. In such instances, the higher elevation standard shall apply.

3109.4 Construction standards.

3109.4.1 Pile foundations. All habitable structures shall be elevated on, and securely anchored to, an adequate pile foundation. Pile foundations for habitable structures shall be designed to withstand all reasonable anticipated erosion, scour and loads resulting from a 100-year storm including wind, wave, hydrostatic and hydrodynamic forces acting simultaneously with typical structural (live and dead) loads. All habitable structures should be anchored to their pile foundation in such a manner as to prevent flotation, collapse or lateral displacement. The elevation of the soil surface to be used in the calculation of pile reactions and bearing capacities for habitable structures shall not be greater than that which would result from erosion caused by a 100-year storm event. Calculation of the design grade shall account for localized scour resulting from the presence of structural components. Design ratio or pile spacing to pile diameter should not be less than 8:1 for individual piles located above the design grade. Pile caps shall be set below the design grade unless designed to resist increased flood loads associated with setting the cap above the design grade, but at or below the natural grade. Pile penetration shall take into consideration the anticipated loss of soil above the design grade.

Exceptions:

1. Additions, repairs or modifications to existing nonconforming habitable structures that do not advance the seaward limits of the existing habitable structure and do not constitute rebuilding of the existing structure.
2. Habitable structures located landward of existing armoring which is capable of protecting buildings from the effects of erosion from a 100-year storm surge. The applicant shall provide scientific and engineering evidence that the armoring has been designed, constructed and maintained to survive the effects of the design storm and provide protection to existing and proposed structures from the erosion associated with that event. Evidence shall include a report with data and supporting analysis, and shall be certified by a professional engineer registered in this state, that the armoring was designed and constructed and is in adequate condition to meet the following criteria:
   - 2.1. The top must be at or above the still water level, including setup, for the design storm plus the breaking wave calculated at its highest achievable level based on the maximum eroded beach profile and highest surge level combination, and must be high enough to preclude runup overtopping.
   - 2.2. The armoring must be stable under the design storm including maximum localized scour, with adequate penetration and toe protection to avoid settlement, toe failure or loss of material from beneath or behind the armoring.
   - 2.3. The armoring must have sufficient continuity or return walls to prevent flanking under the design storm from impacting the proposed construction.
   - 2.4. The armoring must withstand the static and hydrodynamic forces of the design storm.

3109.4.2 Walls below the 100-year storm elevation. No substantial walls or partitions shall be constructed below the level of the first finished floor of habitable structures. All other walls shall be designed to break away.

Exceptions:

1. Stairways and stairwells;
2. Shear walls perpendicular to the shoreline;
3. Shear walls parallel to the shoreline, which are limited to a maximum of 20 percent of the building length in the direction running parallel to the shore;
4. Shear walls parallel to the shoreline, which exceed 20 percent of the total building length (including any attached major structure) when they meet the following criteria:
   - 4.1. A certification is provided by a Florida-registered professional engineer that certifies that the increased length of shear walls, over 20 percent, are located landward of the 100-year erosion limit;
   - 4.2. A hydraulic analysis is provided and certified by a Florida-registered professional engineer that evaluates the potential impact of flow increase on the subject parcel and adjacent properties;
   - 4.3. The hydraulic analysis demonstrates that although the overall shearwall coverage is more than 20 percent, the increased shear-wall length will not result in substantial increase of flow velocities and drag forces on the structural components of the proposed structure and neighboring structures; and
   - 4.4. The provisions under Section 3109.4.2 (Exception 4) do not include any low-rise building as defined in Section 1609.2.
5. Wind or sand screens constructed of fiber or wire mesh;
6. Light, open lattice partitions with individual, wooden lattice strips not greater than $^3/_4$ inch (19 mm) thick and 3 inches (76 mm) wide;
7. Elevator shafts;
8. Small mechanical and electrical rooms; and
9. Break-away or frangible walls.

3109.5 Flood loads during a 100-year storm.

3109.5.1 Load basis. The structural design shall be based on the 100-year storm as determined by the Florida Department of Environmental Protection in studies published as part of the coastal construction control line establishment process. Breaking, broken and nonbreaking waves shall be considered as applicable. Design wave loading analysis shall consider vertical uplift pressures and all lateral pressures to include impact, as well as dynamic loading and the harmonic intensification resulting from repetitive waves.

3109.5.2 Hydrostatic load. Habitable structures shall be designed in consideration of the hydrostatic loads which would be expected under the conditions of maximum inundation associated with a 100-year storm event. Calculations for hydrostatic loads shall consider the maximum water pressure resulting from a fully peaked, breaking wave superimposed on the design storm surge with dynamic wave set-up. Both free and confined hydrostatic loads shall be considered. Hydrostatic loads which are confined shall be determined using the maximum elevation to which the confined water would freely rise if unconfined. Vertical hydrostatic loads shall be considered as forces acting both vertically downward and upward on horizontal or inclined surfaces of major structures (e.g., floors, slabs, roofs, walls). Lateral hydrostatic loads shall be considered as forces acting horizontally above and below grade on vertical or inclined surfaces of major structures and coastal or shore protection structures. Hydrostatic loads on irregular or curving geometric surfaces may be determined in consideration of separate vertical and horizontal components acting simultaneously under the distribution of the hydrostatic pressures.

3109.5.3 Hydrodynamic loads. Habitable structures shall be designed in consideration of the hydrodynamic loads which would be expected under the conditions of a 100-year storm event. Calculations for hydrodynamic loads shall consider the maximum water pressures resulting from the motion of the water mass associated with a 100-year storm event. Full-intensity loading shall be applied on all structural surfaces above the design grade which would affect the flow velocities.

3109.6 Wind loads. All habitable structures shall be designed in accordance with Chapter 16.

3109.7 Swimming pools. Swimming pools located in close proximity to an existing habitable structure or armoring shall be designed with an adequate pile foundation for the erosion and scour conditions of a 100-year storm event.

3109.8 Storm debris. All structures will be designed to minimize the potential for wind- and water-borne debris during a storm.

SECTION 3110 FLOOD-RESISTANT CONSTRUCTION

3110.1 Administration.

3110.1.1 Purpose. The purpose of this standard is to promote the public health, safety and general welfare and to minimize public and private losses resulting from flood conditions in specific areas through the establishment of comprehensive regulations for floodplain management, designed to:

1. Minimize loss of life and property caused by flooding conditions;
2. Prevent unnecessary disruption of commerce and public service in times of flooding;
3. Restrict or prohibit uses which are dangerous to health, safety and property because of flood or erosion hazards, or which result in increases in flood heights or velocities or erosion potential;
4. Require that uses vulnerable to floods, including facilities which serve such uses, be protected against flood damage at the time of initial construction;
5. Control the alteration of natural floodplains, stream channels and natural protective barriers;
6. Control filling, grading, dredging and other development which can increase flood damage or erosion potential;
7. Prevent or regulate the construction of flood barriers which will divert flood waters or which can increase flood hazards; and
8. Contribute to improved construction techniques in the floodplain.

3110.1.2 Floodplain management construction standards. This code specifically defers to the authority granted to local government by Title 44 CFR, Sections 59 and 60. This code is not intended to supplant or supercede local ordinances adopted pursuant to that authority, nor are local floodplain management ordinances to be deemed amendments to the code.

SECTION 3111 DEPOSIT OF MATERIAL IN TIDEWATER REGULATED

3111.1 It is not lawful for any person to discharge or cause to be discharged or deposit or cause to be deposited, in the tide or salt waters of any bay, port, harbor or river of this state, any ballast or material of any kind other than clear stone or rock, free from gravel or pebbles, which said clear stone or rock shall be deposited or discharged only in the construction of enclosures in connection with wharves, piers, quays, jetties or in the construction of permanent bulkheads connecting the solid and permanent portion of wharves. It is lawful to construct three characters of bulkheads for retention of material in solid wharves.

First, clear stone or rock enclosures, or bulkheads, may be built upon all sides to a height not less than 2½ feet (762 mm) above high watermark; and after the enclosures have been made so solid, tight and permanent as to prevent any sand, mud, gravel or other material that may be discharged or deposited in them from drifting or escaping through such enclosures, any kind of ballast may be discharged or deposited within the enclosures. The enclosures may be constructed of wood, stone and rock combined, the stone and rocks to be placed on the outside of the wood to a height not less at any point than 2½ feet (762 mm) above high watermark; and after the enclosures have been made so solid, tight and permanent as to prevent any sand, mud gravel or other material that may be discharged or deposited in them from drifting or escaping through such enclosures, any kind of ballast may be discharged or deposited within the enclosures.

Second, a bulkhead may be built by a permanent wharf consisting of thoroughly creosoted piles not less than 12 inches (305 mm) in diameter at the butt end, to be driven close together and to be capped with timber not less than 10 or 14 inches drift (254 or 302 mm), bolted to each pile, and one or more longitudinal stringers to be placed on the outside of the bulkhead and securely anchored by means of iron rods to piles driven within the bulkheads, clear rock to be on the inside of the bulkhead, to a height of not less than $2^1/_2$ feet (762 mm) above high water; and after this is done, ballast or other material may be deposited within the permanent enclosure so constructed.

Third, a bulkhead may be constructed to consist of creosoted piles, as described herein, driven not exceeding 4 feet (1219 mm) apart from center to center, inside of which two or more longitudinal stringers may be placed and securely bolted to the piles. Inside of these longitudinal pieces, two thicknesses of creosoted sheet piling are to be driven, each course of the sheet piling to make a joint with the other to form an impenetrable wharf; and within this permanent bulkhead so constructed, any ballast or other material may be deposited.

No such enclosure, pier, quay or jetty shall be begun until the point whereat it is to be built shall have been connected by a substantial wharf with a shore or with a permanent wharf; except that the owners of wharves may at any time, with the consent of the Board of Pilot Commissioners of the Division of Professions of the Department of Business and Professional Regulation, build wharves of clear stone or rock, or creosoted walls as hereinafter provided, on each side of their wharves from the shore to a point at which the water is not more than 15 feet (4.6 m) deep, and when such walls have attained a height of $2^1/_2$ feet (762 mm) above high watermark and have been securely closed at the deepwater end by stone or creosoted walls of the same height, any kind of ballast may be deposited in them.

Nothing contained in this section shall interfere with any rights or privileges now enjoyed by riparian owners. While this section empowers those who desire to construct the several characters of wharves, piers, quays, jetties and bulkheads provided for and described herein, nothing in this section shall be construed to require any person not desiring to construct a permanent wharf by filling up with ballast, stone or other material to construct under the specifications contained herein; and nothing in this chapter shall be so construed as to prevent any person from constructing any wharf or placing any pilings, logs or lumber in any waters where the person would have heretofore had the right so to do.

3111.2 This section shall not prohibit Escambia County from placing in Pensacola Bay, on the Escambia County side, beside the old Pensacola Bay Bridge, certain materials, as recommended by the Department of Environmental Protection, in coordination with the Fish and Wildlife Conservation Commission, to increase the number of fish available for persons fishing from the old Pensacola Bay Bridge.

3111.3 This section shall not prohibit Manatee County from placing in the Manatee County portions of Sarasota Bay and Tampa Bay and in the Manatee River, certain materials, as recommended by the Department of Environmental Protection, in coordination with the Fish and Wildlife Conservation Commission, to increase the number of fish available for persons fishing in the above areas.

3111.4 This section shall not prohibit Pinellas County from placing in Tampa Bay certain materials as recommended by the Department of Environmental Protection, in coordination with the Fish and Wildlife Conservation Commission, to increase the number of fish available for persons fishing in the bay. Deposit of material on a wharf or quay is regulated. It is not lawful for any person to deposit or cause to be deposited on any wharf or quay, any ballast, stone, earth or like material, except such wharf or quay may be secured to prevent such ballast or other material from washing into the waters of the harbor.

SECTION 3112
LIGHTING, MIRRORS, LANDSCAPING

3112.1 Each operator of an automated teller machine that controls the access area or defined parking area to be lighted shall comply with Sections (2), (3), and (4) no later than one year after October 1, 1994. If the access area or defined parking area to be lighted is controlled by a person other than the operator, such other person shall comply with Sections (2), (3), and (4) no later than one year after October 1, 1994.

3112.2 Each operator, or other person responsible for an automated teller machine pursuant to Sections 655.960 through 655.965, *Florida Statutes*, shall provide lighting during the hours of darkness with respect to an open and operating automated teller machine and any defined parking area, access area and the exterior of an enclosed automated teller machine installation, as follows:

1. There shall be a minimum of 10 footcandle (108 lux) power at the face of the automated teller machine and extending in an unobstructed direction outward 5 feet (1.5 m).
2. There shall be a minimum of 2 footcandle (21.5 lux) power within 50 feet (15.25 m) in all unobstructed directions from the face of the automated teller machine. If the automated teller machine is located within 10 feet (3 m) of the corner of the building and the automated teller machine is generally accessible from the adjacent side, there shall be a minimum of 2 footcandle (21.5 lux) power along the first 40 unobstructed feet (12 m) of the adjacent side of the building.
3. There shall be a minimum of 2 footcandle (21.5 lux) power in that portion of the defined parking area within 60 feet (18 m) of the automated teller machine.
4. The operator shall provide reflective mirrors or surfaces at each automated teller machine which provide the customer with a rear view while the customer is engaged in using the automated teller machine.
5. The operator, or other person responsible pursuant to Sections 655.960 through 655.965, *Florida Statutes*, for an automated teller machine, shall ensure that the height of any landscaping, vegetation or other physical obstructions in the area required to be lighted pursuant to Section (2) for any open and operating automated teller machine shall not exceed 3 feet (914 mm), except that trees trimmed to a height of 10 feet (3 m) and whose diameters are less than 2 feet (610 mm) and manmade physical obstructions required by statute, law, code, ordinance or other governmental regulation shall not be affected by this section.

SECTION 3113
AIRPORT NOISE

3113.1 Airport noise study guidelines. The Aviation Safety and Noise Abatement Act of 1979, 14 CFR Part 150 (U.S. Department of Transportation), including revisions through January, 2005, is hereby adopted as a guideline for establishing airport noise control.

CHAPTER 32

ENCROACHMENTS INTO THE PUBLIC RIGHT-OF-WAY

SECTION 3201
GENERAL

3201.1 Scope. The provisions of this chapter shall govern the encroachment of structures into the public right-of-way.

3201.2 Measurement. The projection of any structure or portion thereof shall be the distance measured horizontally from the lot line to the outermost point of the projection.

3201.3 Other laws. The provisions of this chapter shall not be construed to permit the violation of other laws or ordinances regulating the use and occupancy of public property.

3201.4 Drainage. Drainage water collected from a roof, awning, canopy or marquee, and condensate from mechanical equipment shall not flow over a public walking surface.

SECTION 3202
ENCROACHMENTS

3202.1 Encroachments below grade. Encroachments below grade shall comply with Sections 3202.1.1 through 3202.1.3.

3202.1.1 Structural support. A part of a building erected below grade that is necessary for structural support of the building or structure shall not project beyond the lot lines, except that the footings of street walls or their supports which are located at least 8 feet (2438 mm) below grade shall not project more than 12 inches (305 mm) beyond the street lot line.

3202.1.2 Vaults and other enclosed spaces. The construction and utilization of vaults and other enclosed space below grade shall be subject to the terms and conditions of the authority or legislative body having jurisdiction.

3202.1.3 Areaways. Areaways shall be protected by grates, guards or other approved means.

3202.2 Encroachments above grade and below 8 feet in height. Encroachments into the public right-of-way above grade and below 8 feet (2438 mm) in height shall be prohibited except as provided for in Sections 3202.2.1 through 3202.2.3. Doors and windows shall not open or project into the public right-of-way.

3202.2.1 Steps. Steps shall not project more than 12 inches (305 mm) and shall be guarded by approved devices not less than 3 feet (914 mm) high, or shall be located between columns or pilasters.

3202.2.2 Architectural features. Columns or pilasters, including bases and moldings shall not project more than 12 inches (305 mm). Belt courses, lintels, sills, architraves, pediments and similar architectural features shall not project more than 4 inches (102 mm).

3202.2.3 Awnings. The vertical clearance from the public right-of-way to the lowest part of any awning, including valances, shall be 7 feet (2134 mm) minimum.

3202.3 Encroachments 8 feet or more above grade. Encroachments 8 feet (2438 mm) or more above grade shall comply with Sections 3202.3.1 through 3202.3.4.

3202.3.1 Awnings, canopies, marquees and signs. Awnings, canopies, marquees and signs shall be constructed so as to support applicable loads as specified in Chapter 16. Awnings, canopies, marquees and signs with less than 15 feet (4572 mm) clearance above the sidewalk shall not extend into or occupy more than two-thirds the width of the sidewalk measured from the building. Stanchions or columns that support awnings, canopies, marquees and signs shall be located not less than 2 feet (610 mm) in from the curb line.

3202.3.2 Windows, balconies, architectural features and mechanical equipment. Where the vertical clearance above grade to projecting windows, balconies, architectural features or mechanical equipment is more than 8 feet (2438 mm), 1 inch (25 mm) of encroachment is permitted for each additional 1 inch (25 mm) of clearance above 8 feet (2438 mm), but the maximum encroachment shall be 4 feet (1219 mm).

3202.3.3 Encroachments 15 feet or more above grade. Encroachments 15 feet (4572 mm) or more above grade shall not be limited.

3202.3.4 Pedestrian walkways. The installation of a pedestrian walkway over a public right-of-way shall be subject to the approval of local authority having jurisdiction. The vertical clearance from the public right-of-way to the lowest part of a pedestrian walkway shall be 15 feet (4572 mm) minimum.

3202.4 Temporary encroachments. Where allowed by the local authority having jurisdiction, vestibules and storm enclosures shall not be erected for a period of time exceeding 7 months in any one year and shall not encroach more than 3 feet (914 mm) nor more than one-fourth of the width of the sidewalk beyond the street lot line. Temporary entrance awnings shall be erected with a minimum clearance of 7 feet (2134 mm) to the lowest portion of the hood or awning where supported on removable steel or other approved noncombustible support.

3202.5 Sidewalk or street obstructions. Unless allowed by the applicable governing authority having jurisdiction of the right-of-way or public property, public property shall be maintained clear of any and all obstructions, including among others, posts, columns, display of wares or merchandise and sidewalk signs.

CHAPTER 33

SAFEGUARDS DURING CONSTRUCTION

SECTION 3301
GENERAL

3301.1 Scope. The provisions of this chapter shall govern safety during construction and the protection of adjacent public and private properties.

3301.2 Storage and placement. Construction equipment and materials shall be stored and placed so as not to endanger the public, the workers or adjoining property for the duration of the construction project.

SECTION 3302
CONSTRUCTION SAFEGUARDS

3302.1 Remodeling and additions. Required exits, existing structural elements, fire protection devices and sanitary safeguards shall be maintained at all times during remodeling, alterations, repairs or additions to any building or structure.

Exceptions:

1. When such required elements or devices are being remodeled, altered or repaired, adequate substitute provisions shall be made.
2. When the existing building is not occupied.

3302.2 Manner of removal. Waste materials shall be removed in a manner which prevents injury or damage to persons, adjoining properties and public rights-of-way.

SECTION 3303
DEMOLITION

3303.1 Construction documents. Construction documents and a schedule for demolition must be submitted when required by the building official. Where such information is required, no work shall be done until such construction documents or schedule, or both, are approved.

3303.2 Pedestrian protection. The work of demolishing any building shall not be commenced until pedestrian protection is in place as required by this chapter.

3303.3 Means of egress. A party wall balcony or horizontal exit shall not be destroyed unless and until a substitute means of egress has been provided and approved.

3303.4 Vacant lot. Where a structure has been demolished or removed, the vacant lot shall be filled and maintained to the existing grade or in accordance with the ordinances of the jurisdiction having authority.

3303.5 Water accumulation. Provision shall be made to prevent the accumulation of water or damage to any foundations on the premises or the adjoining property.

3303.6 Utility connections. Service utility connections shall be discontinued and capped in accordance with the approved rules and the requirements of the authority having jurisdiction.

SECTION 3304
SITE WORK

3304.1 Excavation and fill. Excavation and fill for buildings and structures shall be constructed or protected so as not to endanger life or property. Stumps and roots shall be removed from the soil to a depth of at least 12 inches (305 mm) below the surface of the ground in the area to be occupied by the building. Wood forms which have been used in placing concrete, if within the ground or between foundation sills and the ground, shall be removed before a building is occupied or used for any purpose. Before completion, loose or casual wood shall be removed from direct contact with the ground under the building.

3304.1.1 Slope limits. Slopes for permanent fill shall not be steeper than one unit vertical in two units horizontal (50-percent slope). Cut slopes for permanent excavations shall not be steeper than one unit vertical in two units horizontal (50-percent slope). Deviation from the foregoing limitations for cut slopes shall be permitted only upon the presentation of a soil investigation report acceptable to the building official.

3304.1.2 Surcharge. No fill or other surcharge loads shall be placed adjacent to any building or structure unless such building or structure is capable of withstanding the additional loads caused by the fill or surcharge. Existing footings or foundations which can be affected by any excavation shall be underpinned adequately or otherwise protected against settlement and shall be protected against later movement.

3304.1.3 Footings on adjacent slopes. For footings on adjacent slopes, see Chapter 18.

3304.1.4 Fill supporting foundations. Fill to be used to support the foundations of any building or structure shall comply with Section 1803.5.

SECTION 3305
SANITARY

3305.1 Facilities required. Sanitary facilities shall be provided during construction, remodeling or demolition activities in accordance with the *Florida Building Code, Plumbing*.

SECTION 3306 PROTECTION OF PEDESTRIANS

3306.1 Protection required. Pedestrians shall be protected during construction, remodeling and demolition activities as required by this chapter and Table 3306.1. Signs shall be provided to direct pedestrian traffic.

3306.2 Walkways. A walkway shall be provided for pedestrian travel in front of every construction and demolition site unless the authority having jurisdiction authorizes the sidewalk to be fenced or closed. Walkways shall be of sufficient width to accommodate the pedestrian traffic, but in no case shall they be less than 4 feet (1219 mm) in width. Walkways shall be provided with a durable walking surface. Walkways shall be accessible in accordance with Chapter 11 and shall be designed to support all imposed loads and in no case shall the design live load be less than 150 pounds per square foot (psf) (7.2 kN/m^2).

3306.3 Directional barricades. Pedestrian traffic shall be protected by a directional barricade where the walkway extends into the street. The directional barricade shall be of sufficient size and construction to direct vehicular traffic away from the pedestrian path.

3306.4 Construction railings. Construction railings shall be at least 42 inches (1067 mm) in height and shall be sufficient to direct pedestrians around construction areas.

3306.5 Barriers. Barriers shall be a minimum of 8 feet (2438 mm) in height and shall be placed on the side of the walkway nearest the construction. Barriers shall extend the entire length of the construction site. Openings in such barriers shall be protected by doors which are normally kept closed.

3306.6 Barrier design. Barriers shall be designed to resist loads required in Chapter 16 unless constructed as follows:

1. Barriers shall be provided with 2-inch by 4-inch (51 mm by 102 mm) top and bottom plates.
2. The barrier material shall be a minimum of $^{3}/_{4}$-inch (19.1 mm) boards or $^{1}/_{4}$-inch (6.4 mm) wood structural use panels.
3. Wood structural use panels shall be bonded with an adhesive identical to that for exterior wood structural use panels.
4. Wood structural use panels $^{1}/_{4}$ inch (6.4 mm) or $^{5}/_{16}$ inch (23.8 mm) in thickness shall have studs spaced not more than 2 feet (610 mm) on center (o.c.).
5. Wood structural use panels $^{3}/_{8}$ inch (9.5 mm) or $^{1}/_{2}$ inch (12.7 mm) in thickness shall have studs spaced not more than 4 feet (1219 mm) o.c., provided a 2-inch by 4-inch (51 mm by 102 mm) stiffener is placed horizontally at midheight where the stud spacing exceeds 2 feet (610 mm) o.c.
6. Wood structural use panels $^{5}/_{8}$ inch (15.9 mm) or thicker shall not span over 8 feet (2438 mm).

3306.7 Covered walkways. Covered walkways shall have a minimum clear height of 8 feet (2438 mm) as measured from the floor surface to the canopy overhead. Adequate lighting shall be provided at all times. Covered walkways shall be designed to support all imposed loads. In no case shall the design live load be less than 150 psf (7.2 kN/m^2) for the entire structure.

Exception: Roofs and supporting structures of covered walkways for new, light-frame construction not exceeding two stories in height are permitted to be designed for a live load of 75 psf (3.6kN/m^2) or the loads imposed on them, whichever is greater. In lieu of such designs, the roof and supporting structure of a covered walkway are permitted to be constructed as follows:

1. Footings shall be continuous 2-inch by 6-inch (51 mm by 152 mm) members.
2. Posts not less than 4 inches by 6 inches (102 mm by 152 mm) shall be provided on both sides of the roof and spaced not more than 12 feet (3658 mm) o.c.
3. Stringers not less than 4 inches by 12 inches (102 mm by 305 mm) shall be placed on edge upon the posts.
4. Joists resting on the stringers shall be at least 2 inches by 8 inches (51 mm by 203 mm) and shall be spaced not more than 2 feet (610 mm) o.c.
5. The deck shall be planks at least 2 inches (51 mm) thick or wood structural panels with an exterior exposure durability classification at least $^{23}/_{32}$ inch (18.3 mm) thick nailed to the joists.

TABLE 3306.1 PROTECTION OF PEDESTRIANS

HEIGHT OF CONSTRUCTION	DISTANCE FROM CONSTRUCTION TO LOT LINE	TYPE OF PROTECTION REQUIRED
8 feet or less	Less than 5 feet	Construction railings
	5 feet or more	None
More than 8 feet	Less than 5 feet	Barrier and covered walkway
	5 feet or more, but not more than one-fourth the height of construction	Barrier and covered walkway
	5 feet or more, but between one-fourth and one-half the height of construction	Barrier
	5 feet or more, but exceeding one-half the height of construction	None

For SI: 1 foot = 304.8 mm.

6. Each post shall be knee braced to joists and stringers by 2-inch by 4-inch (51 mm by 102 mm) minimum members 4 feet (1219 mm) long.
7. A 2-inch by 4-inch (51 mm by 102 mm) minimum curb shall be set on edge along the outside edge of the deck.

3306.8 Repair, maintenance and removal. Pedestrian protection required by this chapter shall be maintained in place and kept in good order for the entire length of time pedestrians may be endangered. The owner or the owner's agent, upon the completion of the construction activity, shall immediately remove walkways, debris and other obstructions and leave such public property in as good a condition as it was before such work was commenced.

3306.9 Adjacent to excavations. Every excavation on a site located 5 feet (1524 mm) or less from the street lot line shall be enclosed with a barrier not less than 6 feet (1829 mm) high. Where located more than 5 feet (1524 mm) from the street lot line, a barrier shall be erected when required by the building official. Barriers shall be of adequate strength to resist wind pressure as specified in Chapter 16.

SECTION 3307 PROTECTION OF ADJOINING PROPERTY

3307.1 Protection required. Adjoining public and private property shall be protected from damage during construction, remodeling and demolition work. Protection must be provided for footings, foundations, party walls, chimneys, skylights and roofs. Provisions shall be made to control water runoff and erosion during construction or demolition activities. The person making or causing an excavation to be made shall provide written notice to the owners of adjoining buildings advising them that the excavation is to be made and that the adjoining buildings should be protected. Said notification shall be delivered not less than 10 days prior to the scheduled starting date of the excavation.

SECTION 3308 TEMPORARY USE OF STREETS, ALLEYS AND PUBLIC PROPERTY

3308.1 Storage and handling of materials. The temporary use of streets or public property for the storage or handling of materials or of equipment required for construction or demolition, and the protection provided to the public shall comply with the provisions of the authority having jurisdiction and this chapter.

3308.1.1 Obstructions. Construction materials and equipment shall not be placed or stored so as to obstruct access to fire hydrants, standpipes, fire or police alarm boxes, catch basins or manholes, nor shall such material or equipment be located within 20 feet (6096 mm) of a street intersection, or placed so as to obstruct normal observations of traffic signals or to hinder the use of public transit loading platforms.

3308.2 Utility fixtures. Building materials, fences, sheds or any obstruction of any kind shall not be placed so as to obstruct free approach to any fire hydrant, fire department connection, utility pole, manhole, fire alarm box or catch basin, or so as to interfere with the passage of water in the gutter. Protection against damage shall be provided to such utility fixtures during the progress of the work, but sight of them shall not be obstructed.

SECTION 3309 FIRE EXTINGUISHERS

[F] 3309.1 Where required. All structures under construction, alteration or demolition shall be provided with not less than one approved portable fire extinguisher in accordance with Section 906 and sized for not less than ordinary hazard as follows:

1. At each stairway on all floor levels where combustible materials have accumulated.
2. In every storage and construction shed.
3. Additional portable fire extinguishers shall be provided where special hazards exist, such as the storage and use of flammable and combustible liquids.

3309.2 Fire hazards. The provisions of this code and the *Florida Fire Prevention Code* shall be strictly observed to safeguard against all fire hazards attendant upon construction operations.

SECTION 3310 EXITS

3310.1 Stairways required. Where a building has been constructed to a height greater than one story, or where an existing building exceeding one story in height is altered, at least one temporary lighted stairway shall be provided unless one or more of the permanent stairways are erected as the construction progresses. During construction, the stairway shall be enclosed where the building exterior walls are in place.

3310.2 Maintenance of exits. Required means of egress shall be maintained at all times during construction, demolition, remodeling or alterations and additions to any building.

Exception: Approved temporary means of egress systems and facilities.

3310.3 Stairway floor number signs. Temporary stairway floor number signs shall be provided in accordance with the requirements of Section 1020.1.6.

[F] SECTION 3311 STANDPIPES

3311.1 Where required. Buildings four stories or more in height shall be provided with not less than one standpipe for use during construction. Such standpipes shall be installed where the progress of construction is not more than 40 feet (12 192 mm) in height above the lowest level of fire department access. Such standpipe shall be provided with fire department hose connections at accessible locations adjacent to usable stairs. Such standpipes shall be extended as construction progresses to within one floor of the highest point of construction having secured decking or flooring.

3311.2 Buildings being demolished. Where a building is being demolished and a standpipe exists within such a building, such standpipe shall be maintained in an operable condition so as to be available for use by the fire department. Such standpipe shall be demolished with the building but shall not be demolished more than one floor below the floor being demolished.

3311.3 Detailed requirements. Standpipes shall be installed in accordance with the provisions of Chapter 9.

> **Exception:** Standpipes shall be either temporary or permanent in nature, and with or without a water supply, provided that such standpipes conform to the requirements of Section 905 as to capacity, outlets and materials.

3311.4 Water supply. Water supply for fire protection, either temporary or permanent, shall be made available as soon as combustible material accumulates.

SECTION 3312
AUTOMATIC SPRINKLER SYSTEM

[F] 3312.1 Completion before occupancy. In buildings where an automatic sprinkler system is required by this code, it shall be unlawful to occupy any portion of a building or structure until the automatic sprinkler system installation has been tested and approved, except as provided in Section 109.

[F] 3312.2 Operation of valves. Operation of sprinkler control valves shall be permitted only by properly authorized personnel and shall be accompanied by notification of duly designated parties. When the sprinkler protection is being regularly turned off and on to facilitate connection of newly completed segments, the sprinkler control valves shall be checked at the end of each work period to ascertain that protection is in service.

CHAPTER 34
EXISTING STRUCTURES

SECTION 3401
GENERAL

3401.1 Scope. Alteration, repair, addition, relocation and change of occupancy of existing structures and buildings shall comply with the provisions of the *Florida Building Code, Existing Building*.

Exception: Reserved.

3401.2 Maintenance. Reserved.

3401.3 Compliance with other codes. Reserved.

SECTION 3402
DEFINITIONS
RESERVED

SECTION 3403
ADDITIONS, ALTERATIONS OR REPAIRS
RESERVED

SECTION 3404
FIRE ESCAPES
RESERVED

SECTION 3405
GLASS REPLACEMENT
RESERVED

SECTION 3406
CHANGE OF OCCUPANCY
RESERVED

SECTION 3407
HISTORIC BUILDINGS
RESERVED

SECTION 3408
MOVED STRUCTURES
RESERVED

SECTION 3409
ACCESSIBILITY FOR EXISTING BUILDINGS
RESERVED

SECTION 3410
COMPLIANCE ALTERNATIVES
RESERVED

CHAPTER 35

REFERENCED STANDARDS

This chapter lists the standards that are referenced in various sections of this document. The standards are listed herein by the promulgating agency of the standard, the standard identification, the effective date and title, and the section or sections of this document that reference the standard. The application of the referenced standards shall be as specified in Section 102.4.

AA

Aluminum Association
1525 Wilson Blvd, Suite 600
Arlington, VA 22209

Standard reference number	Title	Referenced in code section number
ADM 2005	Aluminum Design Manual: Part 1-A Specification for Aluminum Structures, Allowable Stress Design; and Part 1-B Specification for Aluminum Structures, Building Load and Resistance Factor Design	1604.3.5, 2002.2, 2003.2
	Specifications for Aluminum Structures	2003.2
	The Aluminum Formed Sheet Building Sheathing Design Guide	2003.2
	The Commentary on Specifications for Aluminum Structures	2003.2
	Engineering Data for Aluminum Structures	2003.2
ASM 35—00	Aluminum Sheet Metal Work in Building Construction (Fourth Edition)	2002.1

AAF

Aluminum Association of Florida, Inc.
1650 Dixie Hwy, Suite 500
Boca Raton, FL 33432

Standard reference number	Title	Referenced in code section number
AAF—07	Guide to Aluminum Construction in High Wind Areas 2007	2002.4.1

AAMA

American Architectural Manufacturers Association
1827 Waldon Office Square, Suite 550
Schaumburg, IL 60173

Standard reference number	Title	Referenced in code section number
101/I.S.2—97	Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors	1008.1.6, 1714.5.2.1, 1714.5.2.2, 2411.3.2.1
101/I.S.2/NAFS—02	Voluntary Performance Specification for Windows, Skylights and Glass Doors	1714.5.2.1, 1714.5.2.1.1, 2405.5, 2612.2
103.3—83	Procedural Guide, Sec. 2 — Engineering Design Rules	2411.3.2.6
203—98	Procedural Guide for the Window Inspection and Notification System	1714.5.2.2
501—05	Method for Test for Exterior Wall	1714.5.2.1, 1714.5.2.1.1, 1714.5.3.3.1, 2405.5, 2411.3.2.1.1, 2612.2
AAMA/WDMA/CSA101/ I.S.2/A440-05	Specifications for Windows, Doors and Unit Skylights	1714.5.2.1
AAMA 450-06	Voluntary Performance Rating Method for Mulled Fenestration Assemblies	1714.5.5.1, 1714.5.5.1.2, 1714.5.5.1.3
AAMA 506-06	Voluntary Specifications for Hurricane Impact and Cycle Testing of Fenestration Products	1609.1.4
AAMA 800–05	Voluntary Specifications and Test Methods for Sealants	2510.8
AAMA 812-04	Voluntary Practice for Assessment of Single Component Aerosol Expanding Polyurethane Foams for Sealing Rough Openings of Fenestration Installations	2510.8
AAMA 1402–86	Standard Specifications for Aluminum Siding, Soffit and Fascia	1404.5.1
AAMA/NPEA/NSA 2100-02	Voluntary Specifications for Sunrooms	2002.6

AASHTO

American Association of State Highway & Transportation Officials
444 North Capitol Street N.W., Suite 249
Washington, DC 20001

Standard reference number	Title	Referenced in code section number
LTS 4	Structural Specifications for Highway Signs, Luminaires and Traffic Signals	1609.1.1

ACI

American Concrete Institute
P.O. Box 9094
Farmington Hills, MI 48333-9094

Standard reference number	Title	Referenced in code section number
117	Standard Tolerances for Concrete Construction and Materials	1920.2
216.1–97	Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies	Table 720.1(2), 721.1
224.3R—95	Joints in Concrete Construction (Reapproved 2001)	1911.2
301	Specifications for Structural Concrete for Buildings	1920.2
315	Manual of Standard Practice for Detailing Reinforced Concrete Structures	1920.2
318—05	Building Code Requirements for Structural Concrete	1604.3.2, 1805.4.2.6,1805.9, 1806.4,1808.2.23.1.1, 1808.2.23.2, 1808.2.23.2.1, 1808.2.23.2.2, 1809.2.3.2, 1809.2.3.2.2, 1810.1.2.2, 1812.8, 1901.2, 1901.3, 1901.4, 1902, 1903.1, 1903.2, 1903.3, 1903.4, 1903.5.1, 1903.6, 1904.4.2, 1905.1.4, 1905.3, 1905.4, 1905.5, 1905.6.5.5, 1905.8.3, 1905.11.3, 1906.1.5, 1906.3, 1906.4.3, 1907.1, 1907.2, 1907.4.1, 1907.6, 1907.7.2, 1907.7.3, 1907.7.4, 1907.7.5, 1907.8, 1907.9, 1907.10, 1907.11, 1907.12, 1907.13, 1908, 1908.1.1, 1908.1.2, 1908.1.3, 1908.1.4, 1908.1.5, 1908.1.6, 1908.1.7, 1908.1.8, 1908.1.9, 1909.1, 1909.3, 1909.4, 1909.5, 1909.6, 1910, 1910.2.1, 1910.2.2, 1910.2.3, 1910.2.4, 1910.3.1, 1910.4.1, 1910.4.2, 1910.4.3, 1910.4.3.1, 1910.5.2, 1913.1, 1918.1, 1918.2, 1919.3, 1920.2, 1921.1, 1922.4.1, 1922.4.3, 1922.6.4, 1926.4.1, 1926.4.3, 1926.5.6, 1928.3.1, 1928.7.2, 2108.3
347	Recommended Practice for Concrete Foamwork	1920.2, 1925.1.1
506	Recommended Practice for Shotcreting	1920.2
506.2	Specification for Shotcrete	1920.2, 1929.1.2, 1929.8.1
530—05	Building Code Requirements for Masonry Structures	1405.5, 1405.5.3, 1405.9, 1604.3.4, 1605.3.1.1, 1618.9,1805.5.2, 1812.7, 2101.2.3, 2101.2.4, 2101.2.5, 2103.11.6, 2106.1, 2106.1.1.1, 2106.1.1.2, 2106.1.1.3, 2106.3, 2106.4, 2106.5, 2106.6, 2107.1, 2107.2, 2107.2.1, 2107.2.2, 2107.2.4, 2107.2.5, 2107.2.6, 2108.1, 2108.2, 2108.3, 2108.4, 2109.1, 2109.2.3.1, 2109.2.3.2, 2114.2, 2121.2.12, 2122.1
530.1—05	Specifications for Masonry Structures	1405.5.1, Table 1704.5.1, Table 1704.5.3, 2103.13.7, 2104.1, 2104.1.1, 2104.3, 2104.4

AF&PA

American Forest & Paper Association
1111 19th St, NW Suite 800
Washington, DC 20036

Standard reference number	Title	Referenced in code section number
AF&PA—87 (HVHZ)	All-Weather Wood Foundation System, Design, Fabrication, Installation Manual	2314.4.7
AF&PA—92	Wood Structural Design Data	2314.4.7
AF&PA—93	Span Tables for Joists and Rafters	2306.1.1, 2308.8, 2308.10.2, 2308.10.3
NDS—05	National Design Specification (NDS) for Wood Construction— with 2005 Supplement	721.6.3.2, 1715.1.1, 1715.1.4, 1805.4.5, 1808.1, 1823.1.8.1, 2306.1, 2306.2.1, 2306.3.2, Table 2306.3.1, Table 2306.4.1, 2306.3.4, 2306.3.5, 2306.4.1, Table 2308.9.3(4), 2314.4.7, 2315.4.1, 2319.17.2.2.1, 2319.17.2.1.3, 2319.17.2.1.5
SDPWS–05	AF&PA Supplement Special Design Provisions for Wind and Seismic	2305.1
T.R. No. 7—87	Permanent Wood Foundation System	1805.4.6, 1807.2, 2304.9.5, 2314.4.7
WCD 1—01	Wood Construction Data No. 1, Details for Conventional Wood Frame Construction	2314.4.7
WCD 3—83	Wood Construction Data No. 3, Design of Wood Formwork for Concrete Structures	2314.4.7
WCD 4—89	Wood Construction Data No. 4, Plank and Beam Framing for Residential Buildings	2306.1.2, 2314.4.7
WCD 5—89	Wood Construction Data No. 5, Heavy Timber Construction Details	2314.4.7
WCD 6—88	Wood Construction Data No. 6, Design of Wood Frame Structures for Permanence	2314.4.7, 2326.2.11
WFCM–01	Wood Frame Construction Manual for One- and Two-family Dwellings	2301.2, 2308.1, 2308.2.1

AHA

American Hardwood Association
1210 West N.W. Highway
Palatine, IL 60067

Standard reference number	Title	Referenced in code section number
A135.4—2004	Basic Hardboard	1404.3.1, 2303.1.6, 2314.4.1
A135.5—2004	Prefinished Hardboard Paneling	2303.1.6, 2304.6.2, 2314.4.1
A135.6—98	Hardboard Siding	1404.3.2, 2303.1.6, 2314.4.1
A194.1—85	Cellulosic Fiber Board	2303.1.5, 2314.4.1
IB Spec. No. 1	Recommended Product and Application Specification —Structural Insulating Roof Deck	2314.4.1
IB Spec. No. 2	Recommended Product and Application Specification —$^1/_2$ inch Fiberboard Nail-Base Sheathing	2314.4.1
IB Spec. No. 3	Recommended Product and Application Specification —$^1/_2$inch Intermediate Fiberboard Sheathing	2314.4.1

AIA

American Institute of Architects
1735 New York Avenue N.W.
Washington, D.C. 20006-5292

Standard reference number	Title	Referenced in code section number
HHCF 06	Guideline for the Design and Construction of Health Care Facilities	419.2.1.2, 419.2.2, 419.3.2, 419.3.3, 419.3.4, 419.3.4.1, 419.3.4.2, 419.3.5, 419.3.5.1, 419.3.5.2, 419.3.6, 419.3.6.1, 419.3.7, 419.3.8.8, 419.3.8.9, 419.3.9, 419.3.10, 419.3.11, 419.3.13, 419.3.15, 419.3.17, 420.2.2, 420.2.5, 421.2.1.2, 421.2.2, 421.3.2, 421.3.2.1, 421.3.2.2, 421.3.3, 421.3.3.2.2, 421.3.3.3, 421.3.4, 421.3.5, 421.3.10

AISC

American Institute of Steel Construction
One East Wacker Drive, Suite 3100
Chicago, IL 60601-2001

Standard reference number	Title	Referenced in code section number
341—05	Seismic Provisions for Structural Steel Buildings, including Supplement No. 1 dated 2006	1613.6.2, 1707.2, 1708.4, 2205.2.1, 2205.2.2, 2205.3, 2205.3.1
360—05	Specification for Structural Steel Buildings	1604.3.3, Table 1704.3, 2203.2, 2205.1, 2205.3
AISC	Tortional Analysis of Steel Members	2214.3
AISC	Detailing for Steel Construction	2214.3
AISC	Engineering for Steel Construction	2214.3
AISC	Iron and Steel Beams - 1873 to 1952	2214.3
AISC	Plastic Design in Steel	2214.3
AISC	Plastic Design of Braced Multistory Steel Frames	2214.3
AISC	Serviceability Design Considerations for Low-Rise Buildings	2214.3, 2223.5.2
AISC	Simple Shear Connection, ASD	2214.3
AISC	Simple Shear Connections, LRFD	2214.3
AISC	Allowable Stress Design, Manual of Steel Construction	2214.3
AISC	Load Resistance Factor Design, Manual of Steel Construction	2214.3
AISC	Metal Building Certification Program, Category MB Certified	2223.11.2

AISI

American Iron and Steel Institute
1140 Connecticut Avenue
Suite 705
Washington, DC 20036

Standard reference number	Title	Referenced in code section number
AISI	Design Manual For Cold-Formed Steel	2214.3
AISI	Design Manual for Structural Tubing	2214.3
Z—2	Designing Fire Protection for Steel Trusses	2214.3
Z—3	Designing Fire Protection for Steel Columns (Beams), No column listed	2214.3

AISI - continued

AISI	Fire-Resistant Steel-Frame Construction	2214.3
AISI	Fire-Safe Structural Steel - A Design Guide	2214.3
AISI	Specifications for Design of Light-Gage Cold-Formed Stainless Structural Members	2214.3
AISI	Specification for the Criteria for Structural Application of Steel Cables for Buildings	2214.3
SG02—01	North American Specification for Design of Cold-Formed Steel Structural Members	2214.3
NAS—01	North American Specification for the Design of Cold-formed Steel Structural Members, including 2004 Supplement	1604.3.3, 2209.1, 2210.1
General—04	Standard for Cold-formed Steel Framing—General Provisions	1604.3.3, 2210.1
Header—04	Standard for Cold-formed Steel Framing—Header Design	2210.2
Lateral—04	Standard for Cold-formed Steel Framing—Lateral Design	2210.5
PM—01	Standard for Cold-formed Steel Framing—Prescriptive Method for One- and Two-family Dwellings, including 2004 Supplement	2210.6
Truss—04	Standard for Cold-formed Steel Framing—Truss Design	1604.3.3, 2210.3
WSD—04	Standard for Cold-formed Steel Framing—Wall Stud Design	2210.4

AITC

American Institute of Timber Construction
Suite 140
7012 S. Revere Parkway
Englewood, CO 80112

Standard reference number	Title	Referenced in code section number
Technical Note 7—96	Calculation of Fire Resistance of Glued Laminated Timbers	721.6.3.3, 2314.4.2
104—03	Typical Construction Details	2306.1, 2314.4.2
106	Code of Suggested Practices	2314.4.2
108–93	Standard for Heavy Timber Construction	2314.4.2
109–98	Standard for Preservative Treatment for Structural Glued Laminated Timber	2314.4.2
110—01	Standard Appearance Grades for Structural Glued Laminated Timber	2306.1, 2314.4.2
112–93	Tongue-and-Groove Heavy Timber Roof Decking	2306.1, 2314.4.2
113—01	Standard for Dimensions of Structural Glued Laminated Timber	2306.1, 2314.4.2
117—04	Standard Specifications for Structural Glued Laminated Timber of Softwood Species	2306.1, 2314.4.2
119—96	Standard Specifications for Structural Glued Laminated Timber of Hardwood Species	2306.1
200—04	Manufacturing Quality Control Systems Manual for Structural Glued Laminated Timber	2306.1
ANSI/AITC A 190.1—02	Structural Glued Laminated Timber	2303.1.3, 2306.1, 2314.4.2, 2315.1.1

ALI

Automotive Lift Institute
P.O. Box 85
Courtland, NY 13045

Standard reference number	Title	Referenced in code section number
ALI ALCTV—98	Standard for Automotive Lifts—Safety Requirements for Construction, Testing and Validation (ANSI)	3001.2

ANSI

American National Standards Institute
25 West 43rd Street, Fourth Floor
New York, NY 10036

Standard reference number	Title	Referenced in code section number
A13.1—96 (Reaffirmed 2002)	Scheme for the Identification of Piping Systems	415.8.6.4
A 41.1	Building Code Requirements for Masonry	2119.1.1, 2121.2.8
A 41.2	Building Code Requirements for Reinforced Masonry	2119.1.1
A 42.1	Specification For Gypsum Plastering	2515.1.1
A 42.4	Standard Specification for Interior Lathing and Furring	2514.1
A 97.1	Specification for the Application and Finishing of Gypsum Wallboard	2517.2
A108.1A—99	Installation of Ceramic Tile in the Wet-set Method, with Portland Cement Mortar	2103.10
A108.1B—99	Installation of Ceramic Tile, quarry Tile on a Cured Portland Cement Mortar Setting Bed with Dry-set or Latex-portland Mortar	2103.10

ANSI - continued

A108.4—99	Installation of Ceramic Tile with Organic Adhesives or Water-cleanable Tile-setting Epoxy Adhesive	2103.10.6
A108.5—99	Installation of Ceramic Tile with Dry-set Portland Cement Mortar or Latex-portland Cement Mortar	2103.9.3, 2103.10.1, 2103.10.2
A108.6—99	Installation of Ceramic Tile with Chemical-resistant, Water Cleanable Tile-setting and -grouting Epoxy	2103.10.3
A108.8—99	Installation of Ceramic Tile with Chemical-resistant Furan Resin Mortar and Grout	2103.10.4
A108.9—99	Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout	2103.10.5
A108.10—99	Installation of Grout in Tilework	2103.10.7
A 112.19.8M—87(R1996)	Suction Fittings for Use in Swimming Pools, Spas, Hot Tubs and Whirlpool Bathtub Appliances	424.2.6.6.2
A118.1—99	American National Standard Specifications for Dry-set Portland Cement Mortar	2103.10.1
A118.3—99	American National Standard Specifications for Chemical-resistant, Water-cleanable Tile-setting and -grouting Epoxy and Water Cleanable Tile-setting Epoxy Adhesive	2103.10.3
A118.4—99	American National Standard Specifications for Latex-portland Cement Mortar	2103.10.2
A118.5—99	American National Standard Specifications for Chemical Resistant Furan Mortar and Grouts for Tile Installation	2103.10.4
A118.6—99	American National Standard Specifications for Cement Grouts for Tile Installation	2103.10.7
A118.8—99	American National Standard Specifications for Modified Epoxy Emulsion Mortar/Grout	2103.10.5
A136.1—99	American National Standard Specifications for Organic Adhesives for Installation of Ceramic Tile	2103.10.6
A137.1—88	American National Standard Specifications for Ceramic Tile	2103.5
A208.1—99	Particleboard	2303.1.7, 2303.1.7.1
Z 53.1	American National Standard Safety Color Code for Marking Physical Hazards	423.4.6, 423.14.6
Z 97.1—84 (R1994)	Safety Glazing Materials Used in Buildings—Safety Performance Specifications and Methods of Test (Reaffirmed 1994)	1618.4.6.3, 2406.1.2, 2409.1, 2411.1.4, 2411.1.6, 3010.1

APA

APA - Engineered Wood Association
P.O. Box 11700
Tacoma, WA 98411-0700

Standard reference number	Title	Referenced in code section number
APA E30	Engineered Wood Construction Guide	2314.4.3
APA PDS-Y510J—04	Plywood Design Specification (revised 1998)	2306.1, Table 2306.3.1, 2306.3.2, 2306.4.1, 2314.4.3
APA PDS—04	Panel Design Specification	2306.1, 2306.3.1, 2306.4.1
APA PDS Supplement 1—90	Design and Fabrication of Plywood Curved Panels (revised 1995)	2306.1, 2314.4.3
APA PDS Supplement 2—92	Design and Fabrication of Plywood-lumber beams (revised 1998)	2306.1, 2314.4.3
APA PDS Supplement 3—90	Design and Fabrication of Plywood Stressed-skin Panels (revised 1996)	2306.1, 2314.4.3
APA PDS Supplement 4—90	Design and Fabrication of Plywood Sandwich Panels (revised 1993)	2306.1, 2314.4.3
APA PDS Supplement 5—95	Design and Fabrication of All-plywood Beams (revised 1995)	2306.1, 2314.4.3
APA B840	Siding Manufacturing Specifications	2314.4.3
APA L350	Design/Construction Guide Diaphragms and Shearwalls	2314.4.3
APA PRP108	Performance Standards and Policies for Structural-Use Panels	2314.4.3, 2315.1.2
APA V910	Plywood Folded Plate Laboratory Report 21	2314.4.3
EWS R540—96	Builders Tips: Proper Storage and Handling of Glulam Beams	2306.1
EWS S475—01	Glued Laminated Beam Design Tables	2306.1
EWS S560—03	Field Notching and Drilling of Glued Laminated Timber Beams	2306.1
EWS T300—02	Glulam Connection Details	2306.1
EWS X440—00	Product Guide—Glulam	2306.1
EWS X450—01	Glulam in Residential Construction —Western Edition	2306.1

ASAE

American Society of Agricultural Engineers
2950 Niles Road
St. Joseph, MI 49085-9659

Standard reference number	Title	Referenced in code section number
EP 484.2 (1998)	Diaphragm Design of Metal-clad, Post-frame Rectangular Buildings	2306.1
EP 486.1 (2000)	Shallow-post Foundation Design	2306.1
EP 559 (1997)	Design Requirements and Bending Properties for Mechanically Laminated Columns	2306.1

ASCE/SEI

American Society of Civil Engineers
Structural Engineering Institute
1801 Alexander Bell Drive
Reston, VA 20191-4400

Standard reference number	Title	Referenced in code section number
3—91	Structural Design of Composite Slabs	1604.3.3, 1920.3, 2209.2, 2214.3
5—05	Building Code Requirements for Masonry Structures	1405.5, 1405.5.2, 1405.9, 1604.3.4, 1618.9, 1704.5, 1704.5.1, Table 1704.5.1, 1704.5.2, 1704.5.3, Table 1704.5.3, 1708.1.1, 1708.1.2, 1708.1.3, 1708.1.4, 1805.5.2, 1812.7, 2101.2.2, 2101.2.3, 2101.2.4, 2101.2.5, 2101.2.6, 2103.1.3.6, 2106.1, 2106.1.1, 2106.1.1.1, 2106.1.1.2, 2106.1.1.3, 2106.3, 2106.4, 2106.5, 2106.6, 2107.1, 2107.2, 2107.3, 2107.4, 2107.5, 2107.6, 2107.7, 2170.8, 2108.1, 2108.2, 2108.3, 2108.4, 2109.1, 2109.2.3.1, 2109.7.3, 2121.2.12, 2122.1
6—05	Specifications for Masonry Structures	1405.5.1, Table 1704.5.1, Table 1704.5.3, 1805.5.2.2, 2103.13.7, 2104.1, 2104.1.1, 2104.3, 2104.4
7—05	Minimum Design Loads for Buildings and Other Structures including Supplement No. 1 and excluding Chapter 14 and Appendix 11A	419.4.2.2.6, 420.4.2.2.6, 423.4.7, 423.9.1, 423.25.4, 423.28.2.6.4, 1514.4, 1605.1, 1605.2.2, 1605.3.1.2, 1605.3.2, 1608.1, 1608.3, 1608.3.4, 1608.3.5, 1608.4, 1608.5, 1608.6, 1608.7, 1608.8, 1608.9, 1609.1.1, 1609.1.4.1, Table 1609.3.1, 1609.4, 1609.7.3, 1612.1.3, 1612.2, 1614.1, 1615.1, 1615.2, 1618.4.8, 1618.9, 1619.1, 1619.2.1, 1619.2.2, 1620.1, 1621.1, 1622.1.1, 1626.1, 2002.6
8—02	Standard Specification for the Design of Cold-formed Stainless Steel Structural Members	1604.3.3, 2209.1, 2214.3
11	Guidelines for Structural Condition Assessment of Existing Buildings	1920.3, 2003.2, 2214.3
19—96	Structural Applications of Steel Cables for Buildings	2207.1, 2207.2
24—05	Flood Resistant Design and Construction	1203.3.2, 1612.4, 1612.5, 3001.2
29—05	Standard Calculation Methods for Structural Fire Protection	721.1
32—01	Design and Construction of Frost Protected Shallow Foundations	1805.2.1

ASHRAE

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
1719 Tullie Circle NE
Atlanta, GA 30329-2305

Standard reference number	Title	Referenced in code section number
52.1—92	Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter ASHRAE Handbook—HVAC Applications	Table 13-420.3.13.7
62—01	Ventilation for Acceptable Indoor Air Quality	Table 13-420.3.13.7

ASME

American Society of Mechanical Engineers
Three Park Avenue
New York, NY 10016-5990

Standard reference number	Title	Referenced in code section number
A17.1-1990		11-4.10
A 17.1—04	Safety Code for Elevators and Escalators includes A17.1a in 2005 Addenda	1607.8.1, 3001.1, 3001.2, 3001.4, 3002.5, 3003.2, 3008.1, 3010.1, 3011.1
A17.1S-05	Supplement to Safety Code for Elevators and Escalators	3001.2
A 17.3—96	Safety Code for Existing Elevators and Escalators	3001.1, 3001.2
A18.1—03	Safety Standard for Platform Lifts and Stairway Chairlifts	3001.1, 3001.2
A90.1—03	Safety Standard for Belt Manlifts	3001.2

ASME - continued

A112.18.19.8M—1987	Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, Hot Tubs and Whirlpool Bathing Appliances	3109.5.1
A112.19.17—2002	Manufactured Safety Vacuum Release Systems (SVRS) for Residential and Commercial Swimming Pool, Spa, Hot Tub and Wading Pool	3109.5.2
A 120.1—01	Safety Requirements for Powered Platforms for Building Maintenance	3001.6
A 924/A924M–99	Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process	2319.19.2.2.7
B16.18—2001	Cast Copper Alloy Solder Joint Pressure Fittings	909.13.1
B16.22—2001	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings	909.13.1
B 18.6.1-97	Wood Screws (Inch Series)	1506.6
B20.1—2003	Safety Standard for Conveyors and Related Equipment	3001.2, 3005.3
B31.3—2002	Process Piping	415.8.6.1

ASTM

ASTM International
100 Barr Harbor Drive
West Conshohocken, PA 19428-2959

Standard reference number	Title	Referenced in code section number
01760—76	Standard Specification for Pressure Treatment of Timber Products	Table 1823
A 6/A 6M— 04a	Specification for General Requirements for Rolled Steel, Structural Steel Bars, Plates, Shapes, and Sheet Piling	2214.3
A 29	Standards for General Requirements for Hot-Rolled and Cold-Finished Carbon and Alloy Steel Bars	1827.1
A 36/A 36M–04	Specification for Carbon Structural Steel	1809.3.1, 2103.13.5
A 82–02	Specification for Steel Wire, Plain, for Concrete Reinforcement	2103.13.5, 2103.13.6
A 123/A 123m–02	Specification for Zinc (Hot-dip Galvanized) Coating on Iron and Steel Products	2103.13.7.2
A 153–03	Specification for Zinc Coating (Hot-dip) on Iron and Steel Hardware	2103.13.7.2, 2304.9.5
A 185–02	Specification for Steel Welded Wire Reinforcement, Plain for Concrete	2103.13.4, 2103.13.5
A 240–04	Standard Specification for Chromium and Chromium-nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications	Table 1507.4.3(1), 2103.13.5
A 252—98 (2002)	Specification for Welded and Seamless Steel Pipe Piles	1809.3.1, 1810.6.1, 1826.1.5.3
A 283/A 283M–03	Specification for Low and Intermediate Tensile Strength Carbon Steel Plates	1809.3.1, 1810.6.1
A 306	Carbon Steel Bars Subject to Mechanical Property Requirements	1827.1
A 307–03	Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength	1911.1, 2103.13.5
A 325—94	Specification for Structural Bolts, Steel, Heat-Treated, 120/105 Ksi Minimum Tensile Strength	2214.3
A 361	Specification for Steel Sheet Zinc-Coated (Withdrawn)	2319.17.1.1
A 416/A 416M–02	Specification for Steel Strand, Uncoated Seven-wire for Prestressed Concrete	1809.2.3.1, 2103.13.6
A 421/A 421M—02	Specification for Uncoated Stress-Relieved Steel Wire for Prestressed Concrete	1922.4.2, 2103.11.6
A 435/A 435M–90 (2001)	Specification for Straight-beam Ultrasonic Examination of Steel Plates	1708.4
A 446	Specification for Steel Sheet, Zinc-coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality	1917.4.4
A 463/A 463M–02a	Specification for Steel Sheet, Aluminum-coated, by the Hot Dip Process	Table 1507.4.3(2)
A 480/A 480M–02	Specification for General Requirements for Flat-rolled Stainless and Heat-resisting Steel Plate, Sheet, and Strip	2103.13.5
A 490—93	Specification for Heat-Treated, Steel Structural Bolts, 150 ksi Minimum Tensile Strength	2214.3
A 496–02	Specification for Steel Wire, Deformed for Concrete Reinforcement	2103.13.3
A 497–01	Specification for Steel Welded Reinforcement Deformed, for Concrete	2103.13.4
A 510–03	Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel	2103.13.6
A 525—87	Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process	1917.4.4, 2214.3, 2517.2, 2517.5.1, 2517.5.4
A 568/A 568M–03	Specification for Steel, Sheet, Carbon, and High-strength, Low-alloy, Hot-rolled and Cold-rolled, General Requirements for	Table 1704.3
A 570/A 570M-98	Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled (withdawn)	1826.1.5.3
A 572/A 572M–04	Specification for High-strength Low-alloy Columbium-vanadium Structural Steel	1809.3.1
A 588/A 588M–04	Specification for High-strength Low-alloy Structural Steel with 50 ksi (345 Mpa) Minimum Yield Point to 4 inches (100 mm) Thick	1809.3.1
A 611	Standard Specification for Structural Steel (SS), Sheet, Carbon, Coil-Rolled	1826.1.5.3, 1917.4.4
A 615/A 615M—04a	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement	1908.1.8, 1920.2, 1920.4, 1922.4.6, 2103.11.1, 2103.11.6
A616/A616M-96a	Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement (withdrawn)	1922.4.6
A 617	Standard Specification for Axle-Steel Reformed and Plain Bars for Concrete Reinforcement	1922.4.6

ASTM - continued

A 641/A 641M–03	Specification for Zinc-coated (Galvanized) Carbon Steel Wire	2103.13.7.1
A 653/A 653M—04a	Specification for Steel Sheet, Zinc-Coated Galvanized or Zinc-Iron Alloy-Coated Galvannealed by the Hot-Dip Process	Table 1507.4.3, 2211.2.2.1, 2319.17.2.2.7
A 690–00a	Standard Specification for High Strength Low-alloy Steel H-piles and Sheet Piling for Use in Marine Environments	1809.3.1
A 706/A 706M—04a	Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement	1903.5.2, 1908.1.3, 1922.4.6
A 722/A 722M—98(2003)	Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete	1922.4.2, 2103.11.6, 2106.1.1.3.1
A 755/A 755M–04	Specification for Steel Sheet, Metallic-coated by the Hot-dip Process and Prepainted by the Coil-coating Process for Exterior Exposed Building Products	Table 1507.4.3(1), Table 1507.4.3(2)
A 767/A 767M—00b	Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement	1922.4.6, 1926.5.5, 2103.11.1
A 775/A 775M—04	Specification for Epoxy-Coated Steel Reinforcing Bars	1922.4.6, 2103.11.1
A 792/A 792M–03	Specification for Steel Sheet, 55% Aluminum-zinc Alloy-coated by the Hot-dip Process	Table 1507.4.3(1), Table 1507.4.3(2)
A 875/A 875M–02a	Standard Specification for Steel Sheet Zinc-5 percent, Aluminum Alloy-coated by the Hot-dip Process	Table 1507.4.3(2)
A 884–02	Specification for Epoxy-coated Steel Wire and Welded Wire Fabric for Reinforcement	2103.13.7.3
A 898/A 898M–91(2001)	Specification for Straight Beam Ultrasonic Examination of Rolled Steel Shapes	1708.4
A 913/A 913M–04	Specification for High-strength Low-alloy Steel Shapes of Structural Quality, Produced by Quenching and Self-tempering Process (QST)	1809.3.1
A 924–04	Standard Specification for General Requirements for Steel Sheet, Metallic-coated by the Hot-dip Process	Table 1507.4.3(1)
B 42–02e01	Specification for Seamless Copper Pipe, Standard Sizes	909.13.1
B 43–04	Specification for Seamless Red Brass Pipe, Standard Sizes	909.13.1
B 68–02	Specification for Seamless Copper Tube, Bright Annealed (Metric)	909.13.1
B 88–03	Specification for Seamless Copper Water Tube	909.13.1
B 101–02	Specification for Lead-coated Copper Sheet and Strip for Building Construction	Table 1404.5.3, Table 1507.4.3(1), Table 1507.2.9.2
B 209–04	Specification for Aluminum and Aluminum Alloy Steel and Plate	Table 1507.4.3(1)
B 251–02e01	Specification for General Requirements for Wrought Seamless Copper and Copper-alloy Tube	909.13.1
B 280–03	Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service	909.13.1
B 370-03	Specification for Cold-rolled Copper Sheet and Strip for Building Construction	1404.5.2, Table 1507.2.9.2, Table 1507.4.3(1)
B 695–00	Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel	2304.9.5
C 5—03	Specification for Quicklime for Structural Purposes	Table 2507.2, 2525.2.3
C 22/C 22M–00	Specification for Gypsum	Table 2506.2
C 27–98 (2002)	Specification for Standard Classification of Fireclay and High-alumina Refractory Brick	2111.5, 2111.8
C 28/C 28M—00e01	Specification for Gypsum Plasters	Table 2507.2
C 31/C 31M—98	Practice for Making and Curing Concrete Test Specimens in the Field	1905.6.3.2, 1905.6.4.2, 1923.2.2.3, 1923.2.3.2
C 33—03	Specification for Concrete Aggregates	721.3.1.4, 721.4.1.1.3, Table 1904.2.1, 1922.1, 1922.2, 1922.2.2
C 34—03	Specification for Structural Clay Load-Bearing Wall Tile	2103.2, 2119.8.3
C 35—95(2001)	Specification for Inorganic Aggregates for Use in Gypsum Plaster	Table 2507.2, 2515.2.1.1
C 36/C 36M—03	Specification for Gypsum Wallboard	Figure 721.5.1(2), Figure 721.5.1(3), Table 721.5.1(2), Table 2506.2, 2517.2
C 37/C 37M—-01	Specification for Gypsum Lath	Table 2507.2, 2514.2
C 39—99ae1	Test Method for Compressive Strength of Cylindrical Concrete Specimens	1923.2.2.3
C 42/C 42M—99	Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete	1923.2.4.1, 1923.2.4.3
C 52-01A	Specification for Gypsum Partition Tile or Block	2119.9.3
C 55—03	Specification for Concrete Brick	Table 721.3.2, 2103.1, 2105.2.2.1.2, 2119.4.3.2, 2119.4.3.3
C 56—96 (2001)	Specification for Structural Clay Non-Load-Bearing Tile	2103.2, 2119.8.3.3
C 57	Specification for Structural Clay Floor Tile	2119.8.3.2
C 59/C 59M–00	Specification for Gypsum Casting and Molding Plaster	Table 2507.2
C 61/C 61M—00	Specification for Gypsum Keene's Cement	Table 2507.2, 2515.2.4
C 62—04	Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)	2103.2, 2105.2.2.1.1, 2119.4.3.1
C 67—03ae01	Test Methods of Sampling and Testing Brick and Structural Clay Tile	721.4.1.1.1, 1507.3.5, 2104.5, 2105.2.2.1.1, 2109.8.1.1, 2119.4.2
C 73–99a	Specification for Calcium Silicate Face Brick (Sand-lime Brick)	Table 721.3.2, 2103.1
C 79–04a	Specification for Treated Core and Nontreated Core Gypsum SHeathing Board	Table 2506.2
C 90—03	Specification for Loadbearing Concrete Masonry Units	Table 721.3.2, 1805.5.2, 2103.1, 2105.2.2.1.2, 2119.7.2
C 91—03a	Specification for Masonry Cement	Table 2103.7(1), Table 2507.2, 2515.2.6
C 94/C 94M—04	Specification for Ready-Mixed Concrete	109.3.1, 1905.8.2, 1924.2.2, 1924.2.3

ASTM - continued

C 109/C 109M–02	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens). 2103.11.1
C 126–99	Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units. 2103.2
C 140–03	Test Method Sampling and Testing Concrete Masonry Units and Related Units.. . . . . 721.3.1.2, 2105.2.2.1.2
C 144—03	Standard Specification for Aggregate for Masonry Mortar 1928.7.2, 2119.12.1.1
C 150—04	Specification for Portland Cement . . . . . 1904, Table 1904.2.3, 1922.1, Table 2103.7(1), Table 2507.2, 2515.2.4
C 172—04	Practice for Sampling Freshly Mixed Concrete 1905.6.3.1, 1923.2.2.2
C 199–84 (2000)	Test Method for Pier Test for Refractory Mortars 2111.5, 2111.8, 2113.12
C 206—03	Specification for Finishing Hydrated Lime . . . . . Table 2507.2, 2525.2.3
C 207–04	Specification for Hydrated Lime for Masonry Purposes . . . . . Table 2103.8(1)
C 208–95 (2001)	Specification for Cellulosic Fiber Insulatin Board . . . . . Table 1508.2, 2303.1.5
C 212—00	Specification for Structural Clay Facing Tile. 2103.2, 2119.8.2
C 216—04a	Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale) 2103.2, 2105.2.2.1.1, 2119.4.3.1
C 270—04	Specification for Mortar for Unit Masonry. . . . . 2103.7, Table 2103.7(2), 2119.12.1
C 315–02	Specification for Clay Flue Linings . . . . . 2113.11.1, Table 2113.16(1)
C 317/C 317M–00	Specification for Gypsum Concrete 1914.1
C 330—04	Specification for Lightweight Aggregates for Structural Concrete 721.1.1, 1905.1.4, 1922.2.2
C 331–04	Specification for Lightweight Aggregates for Concrete Masonry Units 721.3.1.4, 721.4.1.1.3
C 406–00	Specification for Roofing Slate 1507.7.4
C 442/C 442M–04	Specification for Gypsum Backing Board and Coreboard and Gypsum Shaftliner Board . . . . . Table 2506.2
C 471M—01	Standard Test Methods for Chemical Analysis of Gypsum and Gypsum Products 2119.9.2
C 472— 2004	Specification for Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters and Gypsum Concrete . . . . . Table 2506.2, 2119.9.2
C 473—03	Test Method for Physical Testing of Gypsum Panel Products . . . . . Table 2506.2, 2119.9.2
C 474–02	Test Methods for Joint Treatment Materials for Gypsum Board Construction . . . . . Table 2506.2
C 475—01	Specification for Joint Compound and Joint Tape for Finishing Gypsum Wallboard . . . . . Table 2506.2, 2517.2
C 476–02	Specification for Grout for Masonry. 2105.2.2.1.1, 2105.2.2.1.2, 2105.2.2.1.3
C 494/C494M-99	Standard Specification for Chemical Admixtures for Concrete 1917.4.5
C 495–99a	Standard Test Method for Compressive Strength of Lightweight Insulating Concrete 1917.1.1, 1917.1.2, 1917.1.3
C 503–03	Specification for Marble Dimension Stone (Exterior) 2103.4
C 514–01	Specification for Nails for the Application of Gypsum Board . . . Table 720.1(2), Table 720.1(3), Table 2306.4.5, Table 2506.2
C 516–02	Specifications for Vermiculite Loose Fill Thermal Insulation. 721.3.1.4, 721.4.1.1.3
C 547–03	Specification for Mineral Fiber Pipe Insulation. . . . . Table 720.1(2), Table 720.1(3)
C 549–02	Specification for Perlite Loose Fill Insulation 721.3.1.4, 721.4.1.1.3
C 552–03	Standard Specification for Cellular Glass Thermal Insulation. . . . . Table 1508.2
C 557–03	Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing . . . . . Table 2506.2
C 568–03	Specification for Limestone Dimension Stone. 2103.4
C 578—04	Standard Specification for Rigid, Cellular Polysturene Thermal Insulation. 1917.4.12
C 587–02	Specification for Gypsum Veneer Plaster . . . . . Table 2507.2
C 588/C 588M–01	Specification for Gypsum Base for Veneer Plasters. . . . . Table 2507.2
C 595—03	Specification for Blended Hydraulic Cements . . . . . 1922.1.2, Table 2103.7(1), Table 2507.2
C 615–03	Specification for Granite Dimension Stone 2103.4
C 616–03	Specification for Quartz Dimension Stone. 2103.4
C 629–03	Specification for Slate Dimension Stone 2103.4
C 630/C 630M–03	Specification for Water-resistant Gypsum Backing Board. . . . . Table 2506.2
C 631–95a (2000)	Specification for Bonding Compounds for Interior Gypsum Plastering . . . . . Table 2507.2
C 635–00	Specification for the Manufacturer, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings. 803.9.1.1, 2506.2.1
C 636–04	Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels 803.9.1.1
C 645—04	Specification for Nonstructural Steel Framing Members . . . . . 2319.17.1.3, Table 2506.2, Table 2507.2, 2517.2, 2517.5.1, 2517.5.4
C 652—04a	Specification for Hollow Brick (Hollow Masonry Units Made from Clay or Shale). 2103.2, 2105.2.2.1.1, 2119.4.3.1, 2119.4.3.1
C 685/ C 685M—98a	Specification for Concrete Made by Volumetric Batching and Continuous Mixing 1924.2.2
C 728–97E1	Standard Specification for Perlite Thermal Insulation Board . . . . . Table 1508.2
C 744–99	Specification for Prefaced Concrete and Calcium Silicate Masonry Units 2103.1
C 754–04	Specification for Installation of Steel Framing Members to Receive Screw-attached Gypsum Panel Products . . . . . Table 2508.1, Table 2511.1

ASTM - continued

C 794—01	Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants	2415.4
C 796—97	Standard Test Method for Foaming Agents For Use in Producing Cellular Concrete Using Performed Foam	1917.1.1, 1917.1.2, 1917.1.3, 1917.4.6
C 836–03	Specification for High-solids Content, Cold Liquid-applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course	1507.15.2
C 840–04	Specification for Application and Finishing of Gypsum Board	Table 2508.1, 2509.2
C 841–03	Specification for Installation of Interior Lathing and Furring	Table 2508.1, Table 2511.1
C 842–99	Specification for Application of Interior Gypsum Plaster	Table 2511.1, 2511.3, 2511.4
C 843–99e01	Specification for Application of Gypsum Veneer Plaster	Table 2511.1
C 844–99	Specification for Application of Gypsum Base to Receive Gypsum Veneer Plaster	Table 2508.1
C 847–00	Specification for Metal Lath	Table 2507.2
C 887–79a (2001)	Specification for Packaged, Dry Combined Materials for Surface Bonding Mortar	807.2.2, 2103.9
C 897–00	Specification for Aggregate for Job-mixed Portland Cement-based Plasters	Table 2507.2
C 920—05	Specification for Elastomeric Joint Sealants	2415.4, 2510.8.8
C 926—98a	Specification for Application of Portland Cement-Based Plaster	2510.3, Table 2511.1, 2511.3, 2511.4, 2512.1, 2512.1.2, 2512.2, 2512.6, 2512.8.2, 2513.7, 2512.9, 2513.7, 2516.1.1, 2516.1.4
C 931/C 931M–04	Specification for Exterior Gypsum Soffit Board	Table 2506.2
C 932–03	Specification for Surface-applied Bonding Agents for Exterior Plastering	Table 2507.2
C 933–04	Specification for Surface-applied Bonding Agents for Exterior Plastering	Table 2507.2
C 946–91 (2001)	Specification for Practice for Construction of Dry-stacked, Surface-bonded Walls	2103.9, 2109.2.3.2
C 954–00	Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 inch (0.84 mm) to 0.112 inch (2.84 mm) in Thickness	Table 2506.2, Table 2507.2
C 955–03	Standard Specification for Load-bearing Transverse and Axial Steel Studs, Runners Tracks, and Bracing or Bridging, for Screw Application of Gypsum Panel Products and Metal Plaster Bases	Table 2506.2, Table 2507.2
C 956–04	Specification for Installation of Cast-in-place Reinforced Gypsum Concrete	1914.1
C 957–04	Specification for High-solids Content, Cold Liquid-applied Elastomeric Waterproofing Membrane with Integral Wearing Surface	1507.15.2
C 950–04	Specification for Predecorated Gypsum Board	Table 2506.2
C 1002–01	Specification for Steel Self-piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs	Table 2506.2, Table 2507.2
C 1006–84 (2001)	Test Method for Splitting Tensile Strength of Masonry Units	2103.11.1
C 1007–04	Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories	Table 2508.1, Table 2511.1
C 1019–03	Test Method of Sampling and Testing Grout	2105.2.2.1.1, 2105.2.2.1.2, 2105.2.2.1.3
C 1029–02	Specification for Spray-applied Rigid Cellular Polyurethane Thermal Insulation	1507.14.2
C 1032–04	Specification for Woven Wire Plaster Base	Table 2507.2
C 1036—01	Specification for Flat Glass	2411.1.1
C 1047–99	Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base	Table 2506.2, Table 2507.2
C 1048—97b	Standard Specification for Heat-Treated Flat Glass—Kind HS, Kind FT Coated and Uncoated Glass	2411.1.5
C 1063–03	Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement Based Plaster	2109.8.4.6, 2510.3, Table 2511.1, 2512.1.1
C 1072–00a	Standard Text Method for Measurement of Masonry Flexural Bond Strength	2103.11.1
C 1077	Standard Practice for Laboratories Testing Concrete and Congete Apparatus for Use in Construction and Criteria for Laboratory Evaluation	1920.4, 1922.6.2
C 1088–02	Specification for Thin Veneer Brick Units Made from Clay or Shale	2103.2
C 1167—03	Specification for Clay Roof Tiles	1507.3.4, 1507.3.5, 1523.6.5.2
C 1177/C 1177M–04	Specification for Glass Mat Gypsum Substrate for Use as Sheathing	Table 2506.2
C 1178/C 1178M–04	Specification for Glass Mat Water-resistant Gypsum Backing Panel	Table 2506.2
C 1186–02	Specification for Flat Nonasbestos Fiber Cement Sheets	1404.10
C 1225	Specification For Nanasbestos Fiber-Cement Roofing Shingles, Shakes and Slates	1518.5.1
C 1261–04	Specification for Firebox Brick for Residential Fireplaces	2111.5, 2111.8
C 1278/C 1278M–03	Specification for Fiber-reinforced Gypsum Panels	Table 2506.2
C 1280–04	Specification for Application of Gypsum Sheathing	Table 2508.1, 2508.2
C 1281-03	Standard Specification for Preformed Tape Sealants for Glazing Applications	2510.8
C 1283–03e01	Practice for Installing Clay Flue Liners	2113.12
C 1288–01	Standard Specification for Discrete Nonasbestos Fiber-cement Interior Substrate Sheets	2509.2
C 1289–03	Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board	Table 1508.2
C1314–03b	Test Method for Compressive Strength of Masonry Prisms	2105.2.2.2.2, 2105.3.1, 2105.3.2
C 1325–04	Standard Specification for Nonasbestos Fiber-mat Reinforced Cement Interior Substrate Sheets	2509.02

ASTM - continued

C 1328–03a	Specification for Plastic (Stucco Cement)	Table 2507.2
C 1329–04	Specification for Mortar Cement	Table 2103.8(1)
C 1386–98	Specification for Precast Autoclaved Aerated Concrete (PAAC) Wall Construction Units	2102.1, 2103.3, 2105.2.2.1.3
C 1395/1395M–04	Specification for Gypsum Ceiling Board	Table 2506.2
C 1396–02	Standard Specifications for Gypsum Wallboard	Table 2506.2
C 1405–00a	Standard Specification for Glazed Brick (Single Fired, Solid Brick Units)	2103.2
C 1492–03	Standard Specification for Concrete Roof Tile	1507.3.5
D 25—99- e 01	Specification for Round Timber Piles	1809.1.1, 1823.1
D 41—94-00-e01	Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing	Table 1507.10.2, 1514.2.3.2, 1517.6.2.4, 1519.6, 1521.6, 1521.14.1
D 43-94 (2000)	Specification for Coal Tar Primer Used in Roofing, Dampproofing, and Waterproofing	Table 1507.10.2, 1521.14.2, 1517.6.2.4, 1519.6, 1521.6
D 56–02a	Test Method for Flash Point by Tag Closed Tester	307.2
D 86–04b	Test Method for Distillation of Petroleum Products at Atmospheric Pressure	307.2
D 92	Standard Test Method for Flasin and Fire Points by Cleveland Open Cup	1519.2.2
D 93–02a	Test Method for Flash Point By Pensky-Martens Closed Cup Tester	307.2
D 225–04	Specification for Asphalt Shingles (Organic Felt) Surfaced with Mineral Granules	1507.2.5
D 226–97a	Specification for Asphalt-saturated Organic Felt Used in Roofing and Waterproofing	1404.2, 1507.2.3, 1507.3.3, 1507.6.3, 1507.7.3, Table 1507.8, 1607.8.3, 1507.9.3, 1507.9.4, Table 1507.10.2
D 227–03	Specification for Coal-tar saturated Organic Felt Used in Roofing and Waterproofing	Table 1507.10.2
D 256—03	Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics	2612.2
D 312—00	Specification for Asphalt Used in Roofing	Table 1507.10.2, 1519.3, Table 1519.3A, 1519.4, 1521.14.1
D 412—98a (2002)e1	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension	
D 422–63 (2002)	Test Method for Particle-size Analysis of Soils	1802.3.2
D 450—(2000)e1	Specification for Coal-Tar Pitch Used in Roofing, Dampproofing, and Waterproofing	Table 1507.10.2, Table 1519.3B
D 624—00e1	Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers	2415.4
D 635—03	Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position	2606.4, 2612.2
D 638-03	Test Method for Tensile Properties of Plastics	2612.2
D 1079—02	Standard Terminology Relating to Roofing, Waterproofing, and Bituminous Materials	1513.1
D 1143—81 (1994)e01	Test Method for Piles Under Static Axial Compressive Load	1808.2.8.3, 1829.1.7
D 1167	Methods of Testing Asphalt-Base Emulsions for Use as Protective Coatings for Built-Up Roofs	1523.6.5.2
D 1227–00	Specification for Emulsified Asphalt Used as a Protective Coating for Roofing	Table 1507.10.2, 1507.15.2
D 1556	Standard Test Method for Density of Soil In-Place by the Sandcone	1820.3.2, 1834.3.3
D 1557—02	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft^3 (2,700 kN m/m^3)	1803.5, 1820.3.2
D 1586–99	Specification for Penetration Test and Split-barrel Sampling of Soils	1613.5.5
D 1621	Standard Test Method for Compressive Properties of Rigid Cellular Plastics	1523.6.5.2.17.1
D 1622	Standard Test Method for Apparent Pensity of Rigid Cellular Plastics	1523.6.5.2.17.2
D 1623	Standard Test Method for Tersile and Tersile Adhesion Properties of Rigid Cellular Plastics	523.6.5.2.17.3
D 1761—88(2000)	Test Method for Mechanical Fasteners in Wood	1715.1.1, 1715.1.2, 1715.1.3, 1834.3.3, 2314.4.4
D 1836	Specification for Commercial Hexanes	1519.12.1
D 1863—03	Specification for Mineral Aggregate Used on Built-Up Roofs	Table 1507.10.2, 1519.2.1
D 1929—96 (2000)e01	Test Method for Determining Ignition Properties of Plastics	402.14.4, 406.5.2, 1407.11.2.1, 2606.4, 2612.2
D 1970–01	Specification for Self-adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roof Underlayment for Ice Dam Protection	1507.2.4, 1507.2.9.2, 1507.3.9, 1507.5.6, 1507.8.7, 1507.9.8
D 2126	Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging	523.6.5.2.17.4
D 2166–00	Test Method for Unconfined Compressive Strength of Cohesive Soil	1613.5.5
D 2178–97a	Specification for Asphalt Glass Felt Used in Roofing and Waterproofing	Table 1507.10.2
D 2216–98	Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass	1613.5.5
D 2240—03	Standard Test Method for Rubber Property—Durometer Hardness	2415.4
D 2487–00	Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)	Table 1610.1, 1802.3.1
D 2565—00	Standard Practice for Xenon Arc Exposure of Plastics Intended for Outdoor Applications	2612.2
D 2626—04	Specification for Asphalt-Saturated and Coated Organic Felt Base Sheet Used in Roofing	1507.3.3, Table 1507.10.2, 1518.4
D 2822–91 (97)e01	Specification for Asphalt Roof Cement	Table 1507.10.2

ASTM - continued

D 2823–90 (97)e1	Specification for Asphalt Roof Coatings	Table 1507.10.2
D 2842	Standard Test Method for Water Absorption of Rigid Cellular Plastics	1523.6.5.2.17.6
D 2843—99(2004)	Test for Density of Smoke from the Burning or Decomposition of Plastics	2606.4, 2612.2
D 2850–03a	Test Method for Uncolsolidated, Undrained Triaxial Compression Test on Cohesive Soils	1613.5.5
D 2856	Standard Test Method for Open-cell Content of Rigid Cellular Plastics by the Air-Pycnometer.	523.6.5.2.17.5
D 2898—94 (1999)	Test Methods for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing	1505.1, 1516.1, 2303.2.1, 2303.2.3, 2314.4.4, 2327.4, 2329.1
D 2922	Standard Test Method for Density of Soil and Soil Aggregate In-Place by Nuclear Methods (Shallow Depth)	1820.3.2
D 3018	Standard for Specification for Class A Asphalt Shingles Surfaced with Mineral Granules	1523.6.5.1
D 3019–e01 (Supp)	Specification for Lap Cement Used with Asphalt Roll Roofing, Nonfibered, Asbestos Fibered and Nonasbestos Fibered	Table 1507.10.2
D 3161–03b	Test Method for a Wind Resistance of Asphalt Shingles (Fan Induced Method)	1504.1.1, 1507.2.5
D 3200–74 (2000)	Standard Specification and Test Method for Establishing Recommended Design Stresses for Round Timber Construction Poles	2303.1.11
D 3201—94 (1998) el	Test Method for Hygroscopic Properties of Fire-Retardant Wood and Wood-Base Products	2303.2.4, 2314.4.4, 2327.5
D 3201–94 (2003)	Test Method for Hygroscopic Properties of Fire-retardant-treated Wood and Wood-based Products	2303.2.4
D 3278–96e01	Test Methods for Flash Point of Liquids by Small Scale Closed-cup Apparatus	307.2
D 3441	Static Cone Soundings	1834.3.3
D 3462—04	Specification for Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules	1507.2.5, 1523.6.5.1
D 3468–99	Specification for Liquid-applied Neoprene and Chlorosulfonated Polyethylene Used in Roofing and Waterproofing	1507.15.2
D 3498—03	Standard Specifications for Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems	2314.4.4, 2322.1.5
D 3679—05	Specification for Rigid Poly (Vinyl Chloride) (PVC) Siding	1404.9, 1405.13
D 3689–90 (1995)	Method for Testing Individual Piles Under Static Axial Tensile Load	1808.2.8.5
D 3737—05	Practice for Establishing Allowable Properties for Structural Glued Laminated Timber (Glulam)	2303.1.3
D 3746—85 (2002) el	Test Method for Impact Resistance of Bituminous Roofing Systems	1504.7, 1515.2.4
D 3747–79 (2000e01)	Specification for Emulsified Asphalt Adhesive for Adhering Roof Insulation	Table 1507.10.2
D 3787—89	Test Method for Bursting Strength of Textiles-Constant-Rate-of-Traverse (CRT) Ball Burst Test	424.2.17.1.15
D 3909–97b	Specification for Asphalt Roll Roofing (Glass Felt) Surfaced with Mineral Granules	1507.2.9.2, 1507.6.4, Table 1507.10.2
D 3957–03	Standard Practices for Establishing Stress Grades for Structural Members Used in Log Buildings	2303.1.10
D 4022–94 (2000)e01	Specification for Coal Tar Roof Cement, Asbestos Containing	Table 1507.10.2
D 4272—03	Test Method for Total Energy Impact of Plastic Films by Dart Drop	1504.7, 1515.2.4
D 4402	Viscosity Determinations of Unfilled Asphalt Using the Brookfield Thermoset Apparatus	1519.2.3
D 4318–00	Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils	1613.5.5, 1802.3.2
D 4434–04	Specification for Poly (Vinyl Chloride) Sheet Roofing	1507.13.2
D 4477-04a	Standard Specification for Rigid (Unplasticized) Poly (Vinyl Chloride) (PVC) Siding	1404.9, 1404.9.1, 1405.13
D 4479–00	Specification for Asphalt Roof Coatings–Asbestos-free	Table 1507.10.2
D 458–00	Specification for Asphalt Roof Cement, Asbestos-free	Table 1507.10.2
D 4601–98	Specification for Asphalt-coated Glass Fibr Base Sheet Used in Roofing	Table 1507.10.2
D 4637–04	Specification for EPDM Sheet Used in Single-ply Roof Membrane	1507.12.2
D 4829–03	Test Method for Expansion Index of Soils	1802.3.2
D 4869–04	Specification for Asphalt-saturated (Organic Felt) Underlayment Used in Steep Slope Roofing	1507.2.3, 1507.5.3, 1507.6.3, 1507.7.3, 1507.8.3, 1507.9.3
D 4897–01	Specification for Asphalt-coated Glass Fiber VEnting Base Sheet Used in Roofing	Table 1507.10.2
D 4945–00	Test Method for High-strain Dynamic Testing of Piles	1808.2.8.3
D 4990–97a	Specification for Coal Tar Glass Felt Used in Roofing and Waterproofing	Table 1507.10.2
D 5019–96e01	Specification for Reinforced Nonvulcanized Polymeric Sheet Used in Roofing Membrane	1507.12.2
D 5034—95	Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)	24.2.17.1.15
D 5055—04	Specification for Establishing and Monitoring Structural Capacities of Prefabricated Wood I-joists	424.2.14.1.15, 2303.1.2
D 5456—05	Specification for Evaluation of Structural Composite Lumber Products	2303.1.9
D 5516–03	Test Method of Evaluating the Flexural Properties of Fire-retardant treated Softwood Plywood Exposed to the Elevated Temperatures	2303.2.2.1
D 5643–94 (2000)e01	Specification for Coal Tar Roof Cement, Asbestos-free	Table 1507.10.2
D 5664–02	Test Methods for Evaluating the Effects of Fire-retardant-treated Lumber	2303.2.2.2
D 5665–99a	Specification for Thermoplastic Fabrics Used in Cold-applied Roofing and Waterproofing	Table 1507.10.2
D 5726–98	Specification for Thermoplastic Fabrics Used in Hot-applied Roofing and Waterproofing	Table 1507.10.2
D 5957-98	Standard Guide for Flood Testing Horizontal Waterproofing Installation	1519.16.6
D 6083—97a	Specification for Liquid Applied Acrylic Coating Used in RoofingTable	1507.10.2, 1507.15.2, 1523.6.2.1.1, 1523.6.3.1, 1523.6.5.12.2

ASTM - continued

D 6162–00A	Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements	1507.11.2
D 6163–00 E01	Specification for Styrene-Butadiene-Styrene (SBS) Modified Bituminous Sheet Metal Materials Using Glass Fiber Reinforcements	1507.11.2
D 6164–00	Specification for Styrene-Butadiene-Styrene (SBS) Modified Bituminous Sheet Metal Materials Using Polyester Reinforcements	1507.11.2
D 6222–02	Specification for Atactic Polypropylene (APP) Modified Bituminous Sheet Materials Using Polyester Reinforcements	1507.11.2
D 6223–02	Specification for Atactic Polypropylene (APP) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements	1507.11.2
D 6298–00	Specification for Fiberglass Reinforced Styrene-Butadiene-Styrene (SBS) Modified Bituminous Sheets with a Factory Applied Metal Surface	1507.11.2
D 6305–02e01	Practice for Calculating Bending Strength Design Adjustment Factors for Fire-retardant-treated Plywood Roof Sheathing	2303.2.2.1
D 6380-01	Specifications for Asphalt Roll Roofing (Organic Felt)	1507.3.3
D 6381–03	Standard Test Method for Measurement of Asphalt Shingle Mechanical Uplift Resistance	1504.2.1, Table 1504.2.1, 1609.5.2
D 6694–01	Standard Specification for Liquid-applied Silicone Coating Used in Spray Polyurethane Foam Roofing	1507.15.2
D 6754–02	Standard Specification for Ketone Ethylene Ester Based Sheet Roofing	1507.13.2
D 6757–02	Standard Specification for Inorganic Underlayment for Use with Steep Slope Roofing Products	1507.2.3
D 6841-03	Standard Practice for Calculating Design Value Treatment Adjustment Factors for Fire-Retardant-Treated Lumber	2303.2.2.2
D 6878–03	Standard Specification for Thermoplastic Polyolefin Based Sheet Roofing	1507.13.2
D 7158-05	Standard Test Method for Wind Resistance of Sealed Asphalt Shingles (Uplift Force/Uplift Resistance Method)	Table 1507.2.10
E 72–02	Standard Test Methods of Conducting Strength Tests of Panels for Building Construction	2103.11.1
E 84—04	Test Method for Surface Burning Characteristics of Building Materials	402.10, 402.14.4, 406.5.2, 410.3.5.3, 422.2.16.3, 423.11.5, 703.4.2, 719.1, 719.4, 802.1, 803.1, 803.5, 803.6.1, 803.6.2, 1407.10, 1407.10.1, 2303.2, 2314.4.4, 2327.1, 2603.3, 2603.4.1.13, 2603.5.4, 2604.2.4, 2606.4, 2612.2, 2612.3
E 90–04	Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements	1207.2
E 96—00e01	Test Method for Water Vapor Transmission of Materials	1203.2, 1523.6.5.2.17.7
E 108—04	Test Methods for Fire Tests of Roof Coverings	423.12.1, 1505.1, 1513.1, 1516.1, 1523.1.2, 2329.1, 2603.6, 2610.2, 2610.3
E 119—00a	Test Methods for Fire Tests of Building Construction and Materials	410.3.5.2, 703.2, 703.2.1, 703.2.3, 703.3, 704.7, 704.9, 706.7, 711.3.2, 712.3.1, 712.4.1, 712.4.6, 713.1, 713.4, 714.7, 715.2, 716.5.2, 715.5.3.1, 715.6.2, 716.5.2, 716.5.3.1, 716.6.2, Table 721.1(1), 1407.10.2,2103.2, 2603.3, 2603.4, 2603.4.1.13, 2603.5.4, 2604.2.4, 2606.4, 2612.2, 2612.3.1.1, 2612.3.1.4
E 136 2004	Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C	703.4.1
E 163-84E01	Methods of Fire Tests For Window Assemblies (withdrawn)	2121.2.1.2.8
E 328–02	Methods for Stress Relaxation for Materials and Structures	2103.13.6
E 330—02	Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference	1714.5.3, 2415.4, 2415.7.1
E 331—00	Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference	1403.2, 2415.4
E 492–04	Test Method for Laboratory Measurement of Impace Sound Transmission Through Floor-ceiling Assemblies Using the Tapping Machine	1207.3
E 518–03	Standard Test Methods for Flexural Bond STrength of Masonry	2101.3.11.1
E 519–02	Standard Test Method for Diagonal Tension (Shear) in Masonry Assemblages	2103.11.1
E 605–00	Test Method for Thickness and Density of Sprayed Fire-resistive Material (SFRM) Applied to Structural Members	1704.10.3, 1704.10.3.1, 1704.10.3.2, 1704.10.4
E 681–04	Test Methods for Concentration Limits of Flammability of Chemical Vapors and Gases	307.2
E 736–00	Test Method for Cohesion/Adhesion of Sprayed Fire-resistive Materials Applied to Structural Members	1704.10.5
E 814–02	Test Method of Fire Tests of Through-penetration Firestops	702.1, 712.3.1.2, 712.4.1.1, 712.4.1.1.2
E 970–00	Test Method for Critical Radiant Flux of Exposed Attic Floor Insulation Usinsg a Radiant Heat Energy Source	719.3.1
E1300—04e01 or 98 (HVHZ)	Practice for Determining Load Resistance of Glass in Buildings	1714.5.2.1, 2404.1, 2404.2, 2404.3, 2411.2.1.1, 2411.2.1.2, 2411.3.1.2
E1592—01	Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference	1504.3.2, 2411.2.1.2
E 1602–03	Guide for Construction of Solid Fuel-burning Masonry Heaters	2112.2

ASTM - continued

E 1886-02 or 05	Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Storm Shutters Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials	202, 1609.1.4
E 1966 2003	Test Method for Fire-Resistant Joint Systems	202, 702.1, 712.3
E 1966–00	Test Method for Fire-resistant Joint Systems	702.1, 7.13.3
E 1996-02 or 05	Specification for Performance of Exterior Windows, Glazed Curtain Walls, Doors, and Storm Shutters Impact by Windborne Debris in Hurricanes	202, 1609.1.4
E 2307–04	Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-scale, Multistory Test Apparatus	713.4
F 547–01	Terminology of Nails for Use with Wood and Wood-based Materials	Table 2506.2
F 851—87 (2000)	Standard Test Method for Self-Rising Seat Mechanisms	1024.10
F 1346—91 (2003)	Performance Specification for Safety Covers and Labeling Requirements for All Covers for Swimming Pools, Spas and Hot Tubs	424.1.3.9, 424.2.2, 424.2.17
F 1667–03	Specification for Driven Fasteners: Nails, Spikes and Staples	Table 720.1(2), Table 720.1(3), 1507.2.6, 2303.6, Table 2506.2
F 2006–00	Standard/Safety Specification for Window Fall Prevention Devices for Nonemergency Escape (Egress) and Rescue (Ingress) Windows	1405.12.2
F2090–01a	Specification for Window Fall Prevention Devices with Emergency Escape (Egress) Release Mechanisms	1405.12.2
G 53—96	Practice for Operating Light-and Water-Exposure Apparatus (Fluorscent UV-Condensation Type) for Exposure of Nonmetallic Materials	424.17.1.15.2
G 60—01	Standard Practice for Conducting Cyclic Humidity Tests	2319.17.2.2.8
G 85	Standard Practice for Modified Salt Spray (Fog) Testing	1517.5.1, 1517.5.2, 1523.6.5.2.10, 1523.6.5.2.11
G 152–04	Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials	1504.6
G 154–00A	Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials	1504.6
G 155	Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials	2612.2
G 155–04	Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials	1504.6

AWCI

The Association of the Wall and Ceiling Industries International
803 West Broad Street, Suite 600
Falls Church, VA 22046

Standard reference number	Title	Referenced in code section number
12—B—98	Technical Manual 12-B Standard Practice for the Testing and Inspection of Field Applied This—Film Intumescent Fire-resistive Materials; an Annotated Guide, First Edition	1704.11

AWPA

American Wood-Preservers' Association
P.O. Box 5690
Grandbury, TX 76049

Standard reference number	Title	Referenced in code section number
C1—00	All Timber Products—Preservative Treatment by Pressure Processes	1505.6, 2303.1.8, 2314.4.5
C2—01	Lumber, Timber, Bridge Ties and Mine Ties—Preservative Treatment by Pressure Processes	Table 1507.9.5, 1805.4.5, 1805.7.1, 2303.1.8, 2304.11.2, 2304.11.4, 2304.11.7, 2314.4.5
C3—99	Piles—Preservative Treatment by Pressure Processes	1805.4.5, 1809.1.2, 1823.1.3, 2303.1.8, 2314.4.5
C4—99	Poles—Preservative Treatment by Pressure Processes	1805.7.1, 1808.1.2, 2303.1.8, 2314.4.5
C5	Posts - Pressure Treatment	2314.4.5
C6	Cross Ties and Switch Ties Pressure Treatment	2314.4.5
C7	Incised (Red, White & Alaska Yellow Cedar) Poles Butts Thermal Treatment	2314.4.5
C8	Poles (Western Red & Alaska Yellow Cedar) Full Length Thermal Treatment	2314.4.5
C9—00	Plywood—Preservative Treatment by Pressure Processes	2304.11.2, 2304.11.4, 2304.11.7, 2314.4.5
C10	Poles (Lodgepole Pine) Full Length Thermal Treatment	2314.4.5
C11	Wood Blocks for Floors & Platforms Pressure Treatment	2314.4.5
C14—99	Wood for Highway Construction, Pressure Treatment by Pressure Process	2314.4.5
C16—00	Wood Used on Farms, Pressure Treatment by Pressure Process	2314.4.5
C18—99	Standard for Pressure Treated Material in Marine Construction	2314.4.5
C20	Structural Lumber, Fire Retardant Pressure Treatment	2314.4.5

AWPA - continued

C22—96	Lumber and Plywood for Permanent Wood Foundations— Preservative Treatment by Pressure Processes	1805.4.6, 2314.4.5
C23—00	Round Poles and Posts Used in Building Construction— Preservative Treatment by Pressure Processes	2314.4.5
C25	Crossarms Pressure Treatment	2314.4.5
C26	Crossarms, Non-Pressure Treatment	2314.4.5
C28—99	Standard for Preservative Treatment by Pressure Process of Structural Glued Laminated Members and Laminations before Gluing	2314.4.5
C29	Lumber to be Used for the Harvesting, Storage and Transportation of Food Stuffs— Preservative Treatment by Pressure Processes	2314.4.5
M4—02	Standard for the Care of Preservative-Treated Wood Products	1823.1.4, 2314.4.5
M6—96	Brands Used on Forest Products	2315.1.9
U1—04	USE CATEGORY SYSTEM: User Specification for Treated Wood Except Section 6, Commodity Specification H	1403.5, 1505.6, Table 1507.9.5, 1805.4.5, 1805.4.6, 1805.7.1, 1809.1.2, 2303.1.8, 2304.11.2, 2304.11.4, 2304.11.6, 2304.11.7

AWS

American Welding Society
550 N.W. LeJeune Road
Miami, FL 33126

Standard reference number	Title	Referenced in code section number
B2.1	Standard Welding Procedure and Performance Qualification	2214.3
C5.4	Recommended Practice for Stud Welding	2214.3
D1.1—04	Structural Welding Code—Steel	2214.3
D1.2	Structural Welding Code—Aluminum	2003.3
D1.3—98	Structural Welding Code—Sheet Steel	2214.3
D1.4—98	Structural Welding Code—Reinforcing Steel	1903.5.2, 1922.4.4, 1922.4.5, 1926.4.6, 1926.4.8, 2119.1.1, 2214.3
D9.1	Specification for Welding of Sheet Metal	2214.3
D10.9	Standard for Qualification of Welding Procedures and Welders for Piping and Tubing	2214.3

BHMA

Builders Hardware Manufacturers' Association
355 Lexington Avenue, 17th Floor
New York, NY 10017-6603

Standard reference number	Title	Referenced in code section number
A 156.10—99	American National Standard for Power Operated Pedestrian Doors	1008.1.3.2
A 156.19—02	Standard for Power Assist and Low Energy Operated Doors	1008.1.3.2

CGSB

Canadian General Standards Board
222 Queens Street
14th Floor, Suite 1402
Ottawa, Ontario, Canada KIA 1G6

Standard reference number	Title	Referenced in code section number
37-GP-52M (1984)	Roofing and Waterproofing Membrane, Sheet Applied, Elastomeric	1504.7, 1507.12.2
CAN/CGSB 37.54—95	Polyvinyl Chloride Roofing and Waterproofing Membrane	1507.13.2
37-GP-56M (1980)	Membrane, Modified, Bituminous, Prefabricated and Reinforced for Roofing— with December 1985 Amendment	1507.11.2

CPSC

Consumer Product Safety Commission
4330 East West Highway
Bethesada, MD 20814-4408

Standard reference number	Title	Referenced in code section number
16 CFR Part 1201(1977)	Safety Standard for Architectural Glazing Material	2406.1.1, 2406.2.1, 2407.1, 2408.2.1, 2408.3, 2411.1.3, 2411.3.1.3, 2411.4.2, 2612.4.8
16 CFR Part 1209 (1979)	Interim Safety Standard for Cellulose Insulation	719.6
16 CFR Part 1404 (1979)	Cellulose Insulation	719.6
16 CFR Part 1500 (1991)	Hazardous Substances and Articles; Administration and Enforcement Regulations	307.2
16 CFR Part 1500.44 (2001)	Method for Determining Extremely Flammable and Flammable Solids	307.2
16 CFR Part 1507 (2001)	Fireworks Devices	307.2
16 CFR Part 1630 (2000)	Standard for the Surface Flammability of Carpets and Rugs	804.4.1
Pub. No. 362	Safety Barrier Guidelines for Home Pools	424.1.3.1.9

CSA

Canadian Standards Association
5060 Spectrum Way, Suite 100
Mississauga, Ontario, L4W 5N6 Canada

Standard reference number	Title	Referenced in code section number
101/I.S.2/A440—05	Specifications for Windows, Doors and Unit Skylights	1714.5.1, 2405.5

CSSB

Cedar Shake and Shingle Bureau
P.O. Box 1178
Sumas, WA 98295-1178

Standard reference number	Title	Referenced in code section number
CSSB—97	Grading and Packing Rules for Western Red Cedar Shakes and Western Red Shingles of the Cedar Shake and Shingle Bureau	Table 1507.8.4, Table 1507.9.5

DASMA

Door and Access Systems Manufacturers
Association International
1300 Summer Avenue
Cleveland, OH 44115-2851

Standard reference number	Title	Referenced in code section number
107—98 (03)	Room Fire Test Standard for Garage Doors Using Foam Plastic Insulation	2603.4.1.9
108—02	Standard Method for Testing Sectional Garage Doors	1714.5.3.1
115-05	Standard Method for Testing Garage Doors and Rolling Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure	1609.1.4

DECO

Document Engineering Co., Inc.
5210 Stagg Street
Van Nuys, CA 91401

Standard reference number	Title	Referenced in code section number
ANSI Z 358.1 04	Emergency Eyewash and Shower Equipment	Table 420.3.17.2

DOC/NIST

U.S. Department of Commerce
National Institute of Standards and Technology
100 Bureau Drive Stop 3460
Gaithersburg, MD 20899

Standard reference number	Title	Referenced in code section number
CS236	Mat-Formed Particleboard	2314.4.6, 2315.1.6
PS1-95	Construction and Industrial Plywood	2211.2.2.2, 2303.1.4, 2304.6.2, Table 2304.7(4), 2306.3.2, 2314.4.6, 2315.1.2
PS2-92	Performance Standard for Wood Based Structural Use Panels	1809.1.1, 2211.3.1, 2303.1.4, 2304.6.2, Table 2304.7(4), Table 2304.7(5), Table 2306.3.1, 2306.3.2, 2314.4.6, 2315.1.2
PS20-99	American Softwood Lumber Standard	1809.1.1, 2302.1, 2303.1.1, 2314.4.6, 2315.1.8
PS56	Structural Glued Laminated Timber	2314.4.6

DOL/OSHA

U.S. Department of Labor
Occupational Safety and Health Administration
Frances Perkins Building
200 Constitution Avenue, N.W.
Washington, D.C. 20210

Standard reference number	Title	Referenced in code section number
29 CFR Part 1910.1000 (1974)	Air Contaminants	902.1
29CFR Part 1910	Occupational Safety and Health Standards	1618.4
29CFR 1926-950 (p)	Occupational Safety and Health Administration Excavation Safety Act	1817.1

DOT

U.S. Department of Transportation
c/o Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402-9325

Standard reference number	Title	Referenced in code section number
14 CFR Part 150 (2005)	Airport Noise Compatibility Planning, Federal Aviation Administration	3113.1
49 CFR—1998	Specification of Transportation of Explosive and Other Dangerous Articles, UN 0335,UN 0336 Shipping Containers	307.2
49 CFR Parts 173.137 (1990)	Shippers—General Requirements for Shipments and Packaging—Class 8—Assignment of Packing Group	307.2

FC&PA

Florida Concrete & Products Association Inc.
3030 Dade Ave.
Orlando, Fla. 32804

Standard reference number	Title	Referenced in code section number
FC&PA—97	Guide to Concrete Masonry Residential Construction in High Wind Areas	1609.1.1

FEMA

Federal Emergency Management Agency
Federal Center Plaza
500 C Street S.W.
Washington, DC 20472

Standard reference number	Title	Referenced in code section number
44CFR59	Emergency Management and Assistance, General Provisions	423.4.2, 3110.1.2
44CFR60—97	Criteria for Land Management and Use	423.4.2, 3110.1.2
FIA-TB11—01	Crawlspace Construction for Buildings Located in Special Flood Hazard Areas	1807.1.2.1

FINA

Federation Internationale de Natation Amateur
Av. de l' Avant-Poste 4
1005 Lausanne
SWITZERLAND

Standard reference number	Title	Referenced in code section number
CHG-22	FINA Handbook 1998-2000	424.1.2.7

Florida Codes

Florida Building Commission
Building Codes and Standards
Department of Community Affairs
2555 Shumard Oak Blvd.
Tallahassee, FL 32399-2100

Standard reference number	Title	Referenced in code section number
Ch. 11 FBC-B—07	Ch. 11, Florida Building Code, Building (Florida Accessible Code for Building Construction)	101.4.8, 104.11.3, 201.5, 403.1.1, 406.2.2, 412.1.6, 423.10.2.8.7, 423.27.4, 423.28.2.4, 427.1.4.1.1.3, 427.1.4.4.1, 427.1.4.4.2, 1003.3.4, 1003.5.3, 1007.1, 1008.1, 1009.5.3, 1009.11.8, 1009.14, 1010.1, 1010.8, 1010.9, 1208.2, 3001.3
Ch. 13 FBC-B—07	Ch. 13 Florida Building Code, Building (Energy Efficiency)	101.4.7, 201.6, 1202.3.2, 1301.1.1, 1403.2
Ch. 27 FBC-B—07	Ch. 27 Florida Building Code, Building (Electrical Systems)	101.4.1, 102.2.6, 107.3, 414.5.4, 414.9.2.8.1, 415.9.2.8, 419.3.8.3, 419.3.8.8, 419.3.14.2, 419.3.14.4, 419.3.15.2, 420.3.19.3, 420.3.19.5, 420.3.20.2, 420.3.20.3, 421.3.9.3, 421.3.9.5, 421.3.10.10, 423.25.5, 423.25.5.2, 424.1.4.1, 424.1.6.5.16.4.1, 424.1.6.5.1, 424.1.9.8.5, 424.2.16, 425.3.5, 426.3.5, 427.1.4.1.5, 603.1.3, 904.3.1, 907.1.3, 907.5, 907.9.3, 909.11, 909.12.1, 909.16.3, 1006.2.3.4, 1006.2.4, 1205.4.1, 1405.10.4, 2701.1, 2702.1
FEBC—07	Florida Existing Building Code	101.2, 1009.3
FPC—07	Florida Fire Prevention Code	101.4.6, 102.6, 201.3, 307.2, Table 307.7(1), Table 307.7(2), 307.9, Table 307.7(1), Table 307.7(2), 307.9, 308.2, 308.3, 404.2, 406.5.1, 406.5.2, 406.6.1, 410.3.6, 411.1, 412.4.1, 413.1, 414.1.1, 414.1.2, 414.1.2.1, 414.2.4, Table 414.2.4, 414.3, 414.5, 414.5.1, Table 414.5.1, 414.5.2, 414.5.4, 414.5.5, 414.6, 415.1, 415.3, 415.3.1, Table 415.3.1, Table 415.3.2, 415.7, 415.7.1, 415.7.1.4, 415.7.2, 415.7.2.3, 415.7.2.5, 415.7.2.7, 415.7.2.8, 415.7.2.9, 415.7.3, 415.7.3.3.3, 415.7.3.5, 415.7.4, 415.8, 415.9.1, 415.9.2.7, 415.9.5.1, 415.9.7.2, 704.8.2, 706.1, 901.2, 901.3, 901.5, 901.6.2, 903.2.6.1, 903.2.11, Table 903.2.13, 903.5, 904.2.1, 905.1, 906.1, 907.2.5, 907.2.12.2, 907.2.14, 907.2.16, 907.19, 909.20, 910.2.3, Table 910.3, 1001.3, 1203.4.2, 1203.5, 2702.2.8, 2702.2.10, 2702.2.11, 2702.2.12, 2702.3, 3102.1, 3103.1, 3309.2
FBC-FG—07	Florida Building Code, Fuel Gas	101.4.2, 109.3, 201.1, 201.3, 415.7.3, 424.2.1.2, 424.2.15, 425.3.7, 426.6.1, 426.3.6.2, 2113.11.1.2, 2113.15, 2801.1
FBC-M—07	Florida Building Code, Mechanical	101.4.3, 201.3, 202, 307.9, 406.4.2, 406.6.3, 406.6.5, 409.3, 412.4.6, 414.1.2, 414.1.2.1, 414.1.2.2, 414.3, 415.7.1.4, 415.7.2, 415.7.2.8, 415.7.3, 415.7.4, 415.9.11.1, 416.3, 603.1, 707.2, 716.2.2, 716.5.4, 716.6.1, 716.6.2, 716.6.3, 717.5, 719.1, 903.2.12.1, 904.2.1, 904.11, 908.6, 909.1, 909.10.2, 1014.5, 1016.4.1, 1203.1, 1203.2.1, 1203.4.2, 1203.4.2.1, 1203.5, 1209.3, 2304.5, 3004.3.1
FBC-P 07	Florida Building Code, Plumbing	101.4.4, 109.3, 201.3, 415.7.4, 419.3.13.1, 421.3.8.1, 424.2.1.2, 424.2.3, 424.2.8.1, 424.2.13.2, 425.4.2, 426.3.1.2, 426.3.2.1, 427.1.4.1.2, 430.6.1, 603.1.2, 717.5, 903.3.5, 1206.3.3, 1503.4, 1503.4.3, 151.4.2, 1514.4.3, 1807.4.3, 2901.1, 2902.1.1, 3305.1
61C-5	Rule 61C, Florida Administrative Code (Bureau of Elevator Safety Regulations),	3001.1
64E	Rule 64E, Florida Administrative Code (Sewage Disposal)	101.4.4, 2901.1
FBC-R—07	Florida Building Code, Residential	101.2, 308.3, 308.5, 310.1, 1706.1.1
FBC-TPHVHZ—07	Florida Building Code, Test Protocols for High Velocity Hurricane Zones	
	RAS 109	1521.18, 1523.6.2.1
	RAS 111	1503.3, 1504.5, 1514.2, 1514.2.1, 1514.2.2, 1514.2.3, 1514.2.4, 1514.2.5.2, 1514.3, 1514.4.1.1, 1515.2.3.2, 1517.6.1, 1517.6.2.1, 1517.6.2.3, 1517.6.2.5, 1518.5.3, 1518.6.2, 1518.7.3.4, 1518.9.5, 1519.8, 1519.10, 1519.13, 1523.6.5.2.14, 1519.16.5, 1523.6.5.2.14
	RAS 115	1518.7
	RAS 117	1519.7, 1519.11, 1520.4, 1520.5, 1521.7.1, 1521.14.3, 1523.6.5.29
	RAS 118	1518.8.1

Florida Codes - continued

RAS 119 . . . . . 1518.8.1
RAS 120 . . . . . 1518.8.1
RAS 127 . 1518.8.5, 1518.8.6, 1523.6.5.2, 1523.6.5.2.2.2, 1523.6.5.2.2.3, 1523.6.5.2.3.2, 1523.6.5.2.3.3, 1523.6.5.2.6.2, 1525
RAS 128 1525
RAS 130 . . . . . 1518.10
RAS 133 . . . . . 1519.9.2
RAS 150 . . . . . 1519.1
TAS 100 . . . . . 1523.6.5, 1523.6.5.1, 1523.6.5.2, 1523.6.5.2.4, 1523.6.5.2.4.1, 1523.6.5.2.5, 1523.6.5.2.6, 1523.6.5.2.7
TAS 100A 1523.6.5.2.13
TAS 101 . . . . . 1523.6.5.22.2 1523.6.2.22, 1523.6.5.2.2.3
TAS 102 . . . . . 1523.6.5.2.3, 1523.6.5.2.3.2, 1523.6.5.2.3.3, 1523.6.5.2.6.2, 1523.6.5.2.6.3
TAS 102A 1523.6.5.2.3, 1523.6.5.2.3.2, 1523.6.5.2.3.3, 1523.6.5.2.6.2, 1523.6.5.2.6.3
TAS 103 . . . . . 1523.6.5.2.1
TAS 104 . . . . . 1523.6.5.2.1
TAS 105 . . . . . 1513.1, 1519.7.1, 1521.7, 1521.11
TAS 106 . . . . . 1512.4.2.4, 1523.6.5.2.2.4, 1523.6.5.2.3.4, 1523.6.5.2.6.4
TAS 107 . . . . . 1507.2.10, Table 1507.2.10, 1523.6.5.1
TAS 108 . . . . . 1523.6.5.2.2.1, 1523.6.5.2.2.2, 1523.6.5.2.2.3, 1523.6.5.2.3.1, 1523.6.5.2.3.2, 1523.6.5.2.3.3, 1523.6.5.2.6.1, 1523.6.5.2.6.2, 1523.6.5.2.6.3, 1715.2, 1715.2.2
TAS 110 . . . . . 1515.1.4, 1515.2.5, 1520.1, 1520.4, 1523.1.1, 1523.6.2, 1523.6.2.1, 1523.6.3, 1523.6.5.2.4.1, 1523.6.5.2.6, 1523.6.5.2.7, 1523.6.5.2.8, 1523.6.5.2.9, 1523.6.5.2.12, 1523.6.5.2.13.1, 1523.6.5.2.14, 1523.6.5.2.15, 1523.6.5.2.16, 1523.6.5.2.17
TAS 110A 1523.6.5.2.13
TAS 111A 1523.6.5.2.14
TAS 111B 1523.6.5.2.14
TAS 111C 1523.6.5.2.14
TAS 112 . . . . . 1523.6.5.2
TAS 113 . . . . . 1518.8.1.1
TAS 114
1513.1, 1515.1.1, 1515.2.4, 1517.5.1, 1519.5.1, 1520.4, 1523.6.2, 1523.6.2.1, 1523.6.3, 1523.6.5.2.9, 1523.6.5.2.10, 1523.6.5.2.11
TAS 115 . . . . . 1523.6.5.2.6.3
TAS 116 . . . . . 1513.1, 1523.6.5.2.2.1, 1523.6.5.2.3.1, 1523.6.5.2.6.1
TAS 121 . . . . . 1523.6.5.2.12
TAS 123 . . . . . 1518.8.1.1, 1523.6.5.2.15, 1523.6.5.2.17
TAS 123A 1523.6.5.2.16
TAS 124 . . . . . 1521.10, 1523.6.4
TAS 125 . . . . . 1518.9.1, 1523.6.5.2.4.1
TAS 126 . . . . . 1521.12
TAS 135 . . . . . 1523.6.5.2.6
TAS 201 . . . . . 202, 1609.1.4
TAS 202 . . . . . 1609.1.4, 1008.1.6, 1714.5.2.1, 1714.5.2.1.1, 1714.5.3, 1714.6
TAS 203 . . . . . 202, 1609.1.4
TAS 301 . . . . . 1515.1.3

FM

Factory Mutual
Standards Laboratories Department
1151 Boston-Providence Turnpike
Norwood, MA 02062

Standard reference number	Title	Referenced in code section number
4450 (1992)	Approval Standard for Class 1 Insulated Steel Deck Roofs—with Supplements through July 1992	1504.3.1, 1508.1, 2603.3, 2603.4.1.5, 2612.3.2.5.2
4471	Approval Standard for Class I Panel Roofs	1515.1.1
4880 (2001)	American National Standard for Evaluating Insulated Wall or Wall and Roof/Ceiling Assemblies, Plastic Interior Finish Materials, Plastic Exterior Building Panels, Wall/Ceiling Coating Systems, Interior and Exterior Finish Systems	2603.4, 2603.9

FRSA

Florida Roofing, Sheet Metal and
Air Conditioning Contractors Association
4111 Metric Drive
Winter Park, Florida 32792

Standard reference number	Title	Referenced in code section number
FRSA/TRI 07320/8-05	Concrete and Clay Roof Tile Installation Manual, Fourth Edition	1507.3.3, 1507.3.7, 1507.3.8, 1507.3.9

GA

Gypsum Association
810 First Street N.E. #510
Washington, DC 20002-4268

Standard reference number	Title	Referenced in code section number
GA 216—04	Application and Finishing of Gypsum Board	Table 2508.1, 2509.2
GA 600—03	Fire-Resistance Design Manual, 17th Edition	Table 720.1(1), Table 720.1(2), Table 720.1(3)

GSA

General Services Administration
1800 F Street, NW
Washington, DC 20405

Standard reference number	Title	Referenced in code section number
DD-G-451D (1977)	Glass, Flat and Corrugated for Glazing Mirrors and Other Uses	2411.1.2

HPVA

Hardwood Plywood Veneer Association
1825 Michael Faraday Drive
Reston, VA 20190-5350

Standard reference number	Title	Referenced in code section number
HP-1—2000	The American National Standard for Hardwood and Decorative Plywood	2303.3, 2304.6.2

ICC

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

Standard reference number	Title	Referenced in code section number
IBHS-05	Guideline for Hurricane Resistant Residential Construction with errata for the first printing.	1609.1.1, 1609.1.1.1, 2308.2.1
ICC/ANSI A117.1—03	Accessible and Usable Buildings and Facilities	406.2.2, 907.9.1.4,1007.6.5, 1010.1, 1010.6.5, 1010.9, 1011.3, 1101.2, 1102.1, 1103.2.14, 1106.7, 1107.2, 1108.2.2, 1109.1, 1109.2, 1109.2.1.1, 1109.2.2, 1109.3, 1109.4, 1109.8, 3001.3, 3409.6, 3409.8.2, 3409.8.3
ICC 300—02	ICC Standard on Bleachers, Folding and Telescopic Seating and Grandstands	1025.1.1, 3401.1
SBCCI SSTD 11—97	Test Standard for Determining Wind Resistance of Concrete or Clay Roof Tiles	1715.2.1, 1715.2.2
SBCCI SSTD 12—99	Standard for Determining the Wind Resistance from Windborne Debris	423.25.4, 423.25.4.1, 1609.1.2

ISO

International Standards Organization
ISO Central Secretariat1, rue de Varembee, Case postale 56
CH-1211 Geneva 20, Switzerland

Standard reference number	Title	Referenced in code section number
ISO 8115—86	Cotton Bales–Dimensions and Density	Table 415.8.2.1.1

NAAMM

National Association of Architectural
Metal Manufacturers
8 South Michigan Ave
Chicago, IL 60603

Standard reference number	Title	Referenced in code section number
FP 1001—97	Guide Specifications for Design of Metal Flag Poles	1609.1.1

NCMA

National Concrete Masonry Association
2302 Horse Pen Road
Herndon, VA 22071-3499

Standard reference number	Title	Referenced in code section number
TEK 5-84 (1996)	Details for Concrete Masonry Fire Walls	Table 720.1(2)

NFPA

National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02269-9101

Standard reference number	Title	Referenced in code section number
10–02	Standard for Portable Fire Extinguisher	419.4.2.10.2, 420.4.2.10.1.2, 423.28.2.14
11—2005	Low Expansion Foam	904.7
12—2005	Carbon Dioxide Extinguishing Systems	904.8, 904.11 903.3.5.1.1, 904.11, 907.8, 1621.3.10.1, 2121.2.12.8, 3104.5, 3104.9
12A–04	Halon 1301 Fire Extinguishing Systems	904.9
13–02	Installation of Sprinkler Systems	707.3, 903.3.1.1, 903.3.2, 903.3.5.1.1, 903.3.5.2, 904.11, 905.3.4, 907.8, 3104.5, 3104.9
13D—02	Installation of Sprinkler Systems in One- and Two-family Dwellings and Manufactured Homes	903.3.1.3, 903.3.5.1.1
13R—02	Installation of Sprinkler Systems in Residential Occupancies Up to and Including Four Stories in Height	903.3.1.2, 903.3.5.1.1, 903.3.5.1.2, 903.4
14—03	Installation of Standpipe and Hose System	905.2, 905.3.4, 905.4.2, 905.8
16—03	Installation Foam-water Sprinkler and Foam-water Spray Systems	904.7, 904.11
17—02	Dry Chemical Extinguishing Systems	904.6, 904.11
17A—02	Wet Chemical Extinguishing Systems	904.5, 904.11
30—03	Flammable and Combustible Liquids Code	415.3, 423.20.4.1
31—01	Installation of Oil-burning Equipment	2113.15
32—00	Dry Cleaning Plants	415.6.4
40—01	Storage and Handling of Cellulose Nitrate Film	409.1
61—02	Prevention of Fires and Dust Explosions in Agricultural and Food Product Facilities	415.7.1, 423.7.7
70—05	National Electric Code (Excluding Article 80)	2701.1
72—02	National Fire Alarm Code	423.7.7, 436.7.1.1, 436.7.1.3, 416.7.2, 436.10.5.1, 436.10.5.2, 505.4, 901.6, 903.4.1, 904.3.5, 907.2, 907.2.1, 907.2.1.1, 907.2.10, 907.2.10.4, 907.2.11.2, 907.2.11.3, 907.2.12.2.3, 907.2.12.3, 907.4, 907.5, 907.9.2, 907.10, 907.14, 907.16, 907.17, 911.1, 1008.1.3.7.4, 3002.8, 3006.5
80—99	Fire Doors and Fire Windows	508.2.2.1, 715.4, 715.4.5, 715.4.6.1, 715.4.7.2, 715.5, 1008.1.3.3
85—04	Boiler and Combustion System Hazards Code (Note: NFPA 8503 has been incorporated into NFPA 85)	415.6.1
92B—05	Smoke Management Systems in Malls, Atria and Large Spaces	909.8
91—99	Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists and NonCombustible Particulate Solids	423.20.4.1
96	Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations	436.6.2
99—02	Standard for Health Care Facilities	4203.18.1, 420.3.20.2, 420.3.25.1,419.3.18, 419.3.18.8
101—06	Life Safety Code	420.3.3.6, 423.6.1, 423.14.2.1, 423.27.9.1, 423.27.10.1, 427.2.2.1.1.1, 427.1.4.13.2, 427.1.4.2.13, 427.1.4.1.1.2, 427.1.3.1.1.2, 903.6.2, 1024.6.2
105—03	Standard for the Installation of Smoke Door Assemblies	405.4.2, 715.4.3.1, 909.20.4.1
110—05	Emergency and Standby Power Systems	419.3.18, 419.3.18.8, 420.3.25, 1006.2.33, 421.3.13.1 1006.2.3.3, 2702.1
111—05	Stored Electrical Energy Emergency and Standby Power Systems	1006.2.3.3, 2702.1

NFPA - continued

120—99	Coal Preparation Plants	415.6.1
211—03	Chimneys, Fireplaces, Vents and Solid Fuel-burning Appliances	2112.5
230—03	Standard for the Fire Protection of Storage	507.3
252—03	Standard Methods of Fire Tests of Door Assemblies	715.3, 715.4.1, 715.4.2, 715.4.3, 715.4.4.1
253—06	Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source	402.11.1, 406.6.4, 804.2, 804.3
257—00	Standard for Fire Test for Window and Glass Block Assemblies	715.3, 715.4.3.2, 715.5, 715.5.1, 715.5.2, 715.5.8.1
259—04	Test Method for Potential Heat of Building Materials	2603.4.1.10, 2603.5.3, 2612.3.2.4.4
265—02	Method of Fire Tests for Evaluating Room Fire Growth Contribution of Textile Wall Coverings on Full Height Panels and Walls	803.6.2, 803.6.2.1
268—01	Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source	1406.2.1, 1406.2.1.1, 1406.2.1.2, 2603.5.7
285—98	Standard Method of Test for the Evaluation of Flammability Characteristics of Exterior Nonload-bearing Wall Assemblies Containing Combustible Components	1407.10.4, 2603.5.5
286—00	Standard Method of Fire Test for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth	402.15.4, 803.2, 803.2.1, 803.5, 803.6.3, 2603.4, 2603.9
288—01	Standard Methods of Fire Tests of Floor Fire Door Assemblies in Fire-resistance-rated Floor Systems	711.8, 712.4.1.5
303—06	Fire Protection Standards for Marinas and Boatyards	905.3.7
409—01	Aircraft Hangars	412.2.6, 412.4.5
418—01	Standard for Heliports	412.5.5
484—02	Combustible Metals, Metal Powders and Metal Dust	415.6.1
654—06	Prevention of Fire & Dust Explosions from the Manufacturing, Processing and Handling of Combustible Particulate Solids	415.6.1
655—01	Prevention of Sulfur Fires and Explosions	415.6.1
664—02	Prevention of Fires Explosions in Wood Processing and Woodworking Facilities	415.6.1
701—04	Standard Methods of Fire Tests for Flame-propagation of Textiles and Films	402.11.1, 410.3.6, 801.1.2, 806.1, 806.1.2, 806.2, 3102.3, 3102.3.1, 3102.6.1.1, 3105.4
704—01	Standard System for the Identification of the Hazards of Materials for Emergency Response	414.7.2, 415.2
780—97	Installation of Lighting Systems	419.3.19, 420.3.26.1, 423.17.7
1124—06	Manufacture, Transportation, and Storage of Fireworks and Pyrotechnic Articles	415.3.1
2001—04	Clean Agent Fire Extinguishing Systems	904.10

NRCA

National Roofing Contractors Association
10255 W. Higgins Road, Suite 600
Rosemont, IL 60018

Standard reference number	Title	Referenced in code section number
P0405	Roofing and Waterproofing Manual, 5th Edition	1513.1

NSPI

National Spa and Pool Institute
2111 Eisenhower Avenue
Alexandria, VA 22314

Standard reference number	Title	Referenced in code section number
ANSI/NSF	International Standard 50-1996, Circulation System Components and Related Materials for Swimming Pools, Spas/Hot Tubs	424.1.6.5.1, 424.1.6.5.2, 424.1.6.5.16, 424.1.6.5.16.4.2, 424.1.6.5.16.5.2, 424.1.9.2.5.2
ANSI/NSPI 3—99	American National Standard for Permanently Installed Residential Spas	424.2.6.1
ANSI/NSPI 4—99	American National Standard for Aboveground/Onground Residential Swimming Pools	424.2.6.1
ANSI/NSPI 5—03	American National Standard for Residential Inground Swimming Pools	424.2.6.1
ANSI/NSPI 6—92	American National Standard for Residential Portable Spas	424.2.6.1
ANSI/NSPI 7—06	American National Standard for Suction Entrapment Avoidance in Swimming Pools, Wading Pools, Spas, Hot Tubs, and Catch Basins	424.2.6

PCA

Portland Cement Association
5420 Old Orchard Road
Skokie, IL 60077

Standard reference number	Title	Referenced in code section number
EB008-9	Concrete Masonry Handbook	2119.1.1

PCI

Precast Prestressed Concrete Institute
209 West Jackson Boulevard, Suite 500
Chicago, IL 60606-4938

Standard reference number	Title	Referenced in code section number
MNL 124—89	Design for Fire Resistance of Precast Prestressed Concrete	721.2.3.1
MNL 128—01	Recommended Practice for Glass Fiber Reinforced Concrete Panels	1903.2

PTI

Post-Tensioning Institute
1717 W. Northern Avenue, Suite 114
Phoenix, AZ 85021

Standard reference number	Title	Referenced in code section number
PTI—2004	Standard Requirements for Analysis of Shallow Concrete Foundations on Expansive Soils, First Edition	1805.8.2
PTI—2004	Standard Requirements for Design of Shallow Post-tensioned Concrete Foundation on Expansive Soils	1805.8.2

RCSC

Research Council on Structural Connections
c/o Stanley D. Lindsey & Assoc. Ltd.
2244 Metro Center Blvd., Suite 208
Nashville, TN 37228-1320

Standard reference number	Title	Referenced in code section number
RCSC—88	Specification for Structural Joints Using ASTM A 325 or A 490 Bolts	2214.3

RMI

Rack Manufacturers Institute
8720 Red Oak Boulevard, Suite 201
Charlotte, NC 28217

Standard reference number	Title	Referenced in code section number
RMI (2002)	Specification for Design, Testing and Utilization of Industrial Steel Storage Racks	2208.1
10100	Manual of Safety Practices - A Code of Practices for the Use of Industrial and Commercial Steel Storage Racks	2214.3
10150	Industrial Steel Storage Racks Manual	2214.3
10083	Specification for the Design, Testing and Utilization of Industrial Steel Storage Racks	2208.1

SDI

Steel Deck Institute
PO Box 25
Fox River Grove, IL 60021

Standard reference number	Title	Referenced in code section number
DDP	Deck Damage and Penetrations	2214.3
DDM—02	Diaphragm Design Manual	2214.3, 2222.4
Number 30	Design Manual For Composite Decks, Form Decks and Roof Decks	2214.3
MOC1	Manual of Construction with Steel Deck	2214.3
SPD2	Standard Practice Details	2214.3

SDI

Steel Door Institute
c/o Wherry Associates
30200 Detroit Road,
Cleveland, Ohio 44145-1967

Standard reference number	Title	Referenced in code section number
ANSI A250.13—03	Testing and Rating of Severe Windstorm Resistant Components For Swinging Door Assemblies	1609.1.4.2, 1714.5.3.3.2

SFPA

Southern Forest Products Association
PO Box 641700
Kenner, LA 70064-1700

Standard reference number	Title	Referenced in code section number
2001	Permanent Wood Foundations: Design and Construction Guide (Replaces AF&PA Technical Report No. 7)	2314.4.7

SFPE

Society of Fire Protection Engineers
7315 Wisconsin Avenue, Suite 620E
Bethesda, MD 20814

Standard reference number	Title	Referenced in code section number
SFPE	Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings	104.11

SJI

Steel Joist Institute
3127 10th Avenue, North
Myrtle Beach, SC 29577-6760

Standard reference number	Title	Referenced in code section number
JG-1.1—05	Standard Specification for Joist Girders	1604.3.3, 2206.1
K-1.1—05	Standard Specification for Open Web Steel Joists, K-Series	1604.3.3, 2206.1
LH/DLH-1.1—05	Standard Specification for Longspan Steel Joists, LH Series and Deep Longspan Steel Joists, DLH Series	1604.3.3, 2206.1
SJI—71	Structural Design of Steel Joist Roofs to Resist Ponding Loads, Technical Digest No. 3	2214.3
SJI—88	Vibration of Steel Joist-Concrete Slab Floors, Technical Digest No. 5	2214.3
SJI—03	Structural Design of Steel Joist Roofs to Resist Uplift Loads, Technical Digest No. 6	2214.3
SJI—83	Welding of Open Web Steel, Technical Digest No. 8	2214.3
SJI—87	Handling and Erection of Steel Joists and Joist Girders, Technical Digest No. 9	2214.3
SJI—02	Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders	1604.3.3, 2206, 2214.3
SJI—03	75-Year Steel Joist Manual	2214.3

SMA

Storage Equipment Manufacturers Association
8720 Red Oak Blvd, Suite 201
Charlotte, NC 28217

Standard reference number	Title	Referenced in code section number
ANSI/SMA MH281—97	Specification of Industrial Grade Steel Shelving	2214.3

SMACNA

Sheet Metal and Air Conditioning Contractors' National Association
8224 Old Courthouse Rd.
Vienna, VA 22180

Standard reference number	Title	Referenced in code section number
SMACNA—2003	Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems	419.2.1.3, 420.2.3, 421.2.1.3
	Metal Roof and Wall Systems	RAS 133-9.2

SPRI

Single-Ply Roofing Institute
77 Rumford Ave.
Suite 3-B
Walthem, MA 02453

Standard reference number	Title	Referenced in code section number
ES-1—03	Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems	1503.3, 1504.5
RP-4—02	Wind Design Guide for Ballasted Single-ply Roofing Systems	1504.4

SSPC

The Society for Protective Coatings
40 24th Street, 6th Floor
Pittsburgh PA 15222-4656

Standard reference number	Title	Referenced in code section number
SSPC - Paint 15	Steel Joist Shop Paint	2214.3
SSPC/AISC	Guide to the Shop Painting of Structural Steel	2214.3

STI

Steel Tube Institute
522 Westgate Tower
Cleveland, OH 44116

Standard reference number	Title	Referenced in code section number
STI	Manual of Cold-Formed Welded Structural Steel Tube	2214.3

TECO

Timber Company, Inc.
2402 Daniels Street
Madison, WI 53704

Standard reference number	Title	Referenced in code section number
TECO PRP-133	Performance Standards and Policies for Structural Use Panels	2314.4.8, 2315.1.2

TIA

Telecommunications Industry Association
2500 Wilson Boulevard
Arlington, VA 22201-3834

Standard reference number	Title	Referenced in code section number
ANSI/TIA/EIA-222-G—05	Structural Standards for Steel Antenna Towers and Antenna Supporting Structures	1609.1.1, 3108.4

TMS

The Masonry Society
3970 Broadway, Unit 201-D
Boulder, CO 80304-1135

Standard reference number	Title	Referenced in code section number
0216—97	Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies	Table 720.1(2), 721.1
402—05	Building Code Requirements for Masonry Structures	1405.5, 1405.5.2, 1405.9, 1604.3.4, 1704.5, 1704.5.1, Table 1704.5.1, 1704.5.2, 1704.5.3, Table 1703.4.5.3, 1708.1.1, 1708.1.2, 1708.1.3, 1708.1.4, 1805.5.2, 1812.7, 2101.2.2, 2101.2.3, 2101.2.4, 2101.2.5, 2101.2.6, 2103.1.3.6, 2106.1, 2106.1.1, 2106.1.1.1, 2106.1.1.2, 2106.1.1.3, 2106.3, 2106.4, 2106.5, 2106.6, 2107.1, 2107.2, 2107.3, 2107.4, 2107.5, 2107.6, 2107.7, 2107.8, 2108.1, 2108.2, 2108.3, 2108.4, 2109.1, 2109.2.3.1, 2109.7.3
602—05	Specification for Masonry Structures	1405.5.1, Table 1704.5.1, Table 1704.5.3, 2103.13.7, 2104.1, 2104.1.1, 2104.3, 2104.4

TPI

Truss Plate Institute
583 D'Onofrio Drive, Suite 200
Madison, WI 53719

Standard reference number	Title	Referenced in code section number
TPI 1—2002	National Design Standards for Metal-plate-connected Wood Truss Construction	2303.4, 2306.1, 2314.4.9, 2319.17.2.1.1, 2319.17.2.2.8
TPI/WTCA BCSI-06	Building Component Safety Information Guide to Good Practice for Handling, Installing, Restraining and Bracing of Metal Plate Connected Wood Trusses [A Joint publication with WTCA representing the Structural Building Components Industry]	2314.4.9, 2319.17.2.4.1, 2319.17.2.4.3

UL

Underwriters Laboratories, Inc.
333 Pfingsten Road
Northbrook, IL 60062-2096

Standard reference number	Title	Referenced in code section number
9—00	Standard For Fire Tests of Window Assemblies	2121.2.12.8
10A—98	Tin Clad Fire Doors—with Revisions through March 2003	715.4
10B—97	Fire Tests of Door Assemblies—with Revisions through October 2001	715.4.2
10C—98	Positive Pressure Fire Tests of Door Assemblies—with Revisions through November 2001	715.4.1, 715.4.3
14B—98	Sliding Hardware for Standard Horizontally Mounted Tin Clad Fire Doors—with Revisions through July 2000	715.4
14C—99	Swinging Hardware for Standard Tin Clad Fire Doors Mounted Singly and in Pairs	715.4
94—96	Test for Flammability of Plastic Materials for Parts in Devices and Appliances	402.11.1
103—01	Factory-built Chimneys, for Residential Type and Building Heating Appliances	717.2.5
127—96	Factory-built Fireplaces—with Revisions through November1999	717.2.5, 2111.11
181—96	Standard for Factory-Made Air Ducts and Air Connectors	419.3.11.6
199E—04	Outline of Investigation for Fire Testing of Sprinklers and Water Spray Nozzles for Protection of Deep Fat Fryers	904.11.4.1
217—97	Single and Multiple Station Smoke Alarms—with revisions through January 2004	907.2.10
268—96	Smoke Detectors for Fire Protective Signaling Systems—with Revisions through January 1999	407.6, 907.2.6.2
300—96	Fire Testing of Fire Extinguishing Systems for Protection of Restaurant Cooking Areas —with Revisions through December 1998	904.11
555—99	Fire Dampers—with Revisions through January 2002	716.3
555C—96	Ceiling Dampers	716.3, 716.6.2
555S—99	Smoke Dampers—with Revisions through January 2002	716.3, 716.3.1.1
580—94	Test for Uplift Resistance of Roof Assemblies—with Revisions through February 1998	1504.3.1, 1504.3.2, 2214.3, 2222.4.6
641—95	Type L Low-temperature Venting Systems—with Revisions through April 1999	2113.11.1.4
710B—2004	Recirculating Systems	904.11
790—04	Tests for Fire Resistance of Roof Covering Materials—with Revisions through July 1998	1505.1, 1513.1, 1516.1, 1523.1.2, 2314.4.10, 2603.6, 2610.2, 2610.3
793—97	Standards for Automatically Operated Roof Vents for Smoke and Heat	910.3.1
864—03	Standards For Control Units and Accessories for Fire Alarm Systems—with Revisions through October 2003	909.12
924	Standard for Emergency Lighting and Power Equipment	1006.3.6
1040—96	Fire Test of Insulated Wall Construction—with Revisions through April 2001	1407.10.3, 2603.4, 2603.9
1256—02	Fire Test of Roof Deck Construction – with Revisions through March 2000	l508.1, 2603.3, 2603.4.1.5, 2612.3.2.5.2
1479—94	Fire Tests of Through-penetration Fire stops—with Revisions through August 2000	712.3.1.2, 712.4.1.1.2, 712.5
1482—98	Solid-fuel Type Room Heater—with Revisions through January 2000	2112.2, 2112.5
1715—97	Fire Test of Interior Finish Material—with Revisions through October 2002	1407.10.2, 1407.10.3, 2603.4, 2603.9
1777—04	Chimney Liners—with Revisions through July 1998	2113.11.1, 2113.19
1784—2001	Air Leakage Tests of Door Assemblies	707.14.1, 710.5.2, 715.4.3.1, 715.4.5.1, 715.4.5.3
1897—98	Uplift Tests for Roof Covering Systems—with Revisions through November 2002	1504.3.1
1975—96	Fire Test of Foamed Plastics Used for Decorative Purposes	402.10, 402.11.1, 402.15.5
2017—2000	Standards for General-purpose Signaling Devices and Systems—with Revisions through June 2004	3109.4.1.8
2079—98	Tests for Fire Resistance of Building Joint Systems	702.1, 713.3, 713.6

UL - continued

2200—98	Stationary Engine Generator Assemblies (Revisions through July 2004)	2702.1.1
2390—04	Test Method for Measuring the Wind Uplift Coefficients for Asphalt Shingles	1504.2.1, 1609.5.2

ULC

Underwriters Laboratories of Canada
7 Crouse Road
Scarborough, Ontario, Canada M1R3A9

Standard reference number	Title	Referenced in code section number
CAN/ULC S102.2—1988	Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings and Miscellaneous Materials and Assemblies with 2000 Revisions	719.4

USC

United States Code
c/o Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402-9325

Standard reference number	Title	Referenced in code section number
18 USC Part 1, Ch.40	Importation, Manufacture, Distribution and Storage of Explosive Materials	307.2

WDMA

Window and Door Manufacturers Association
1400 East Touhy Avenue #470
Des Plaines, IL 60018

Standard reference number	Title	Referenced in code section number
101/I.S.2/A440—05	Specifications for Windows, Doors and Unit Skylights	1714.5.1, 2405.5

WPPC

Wood Products Promotional Council
c/o Florida Wood Council
1300 Limit Avenue
Mount Dora, FL 32758

Standard reference number	Title	Referenced in code section number
WWPC—97	Guide to Wood Construction in High Wind Areas	1609.1.1, 1609.1.1.1

WRI

Wire Reinforcement Institute, Inc.
203 Loudon Street, S.W.
2nd Floor, Suite 203C
Leesburg, VA 22075

Standard reference number	Title	Referenced in code section number
WRI/CRSI—81	Design of Slab-on-ground Foundations—with 1996 Update	1805.8.2

CHAPTER 36

FLORIDA FIRE PREVENTION CODE

SECTION 3601
GENERAL

3601.1 Scope. Provisions of this chapter shall govern the design, construction and arrangement of elements to provide a safe means of egress from buildings and structures and to minimize hazard to life and property due to fire and panic.

3601.2 In addition to the provisions of this code, buildings shall comply with the 2007 *Florida Fire Prevention Code* as adopted by the Florida State Fire Marshal.

APPENDIX A

EMPLOYEE QUALIFICATIONS

RESERVED

APPENDIX B

CHAPTER 9B-52 F.A.C.
FLORIDA STANDARD FOR PASSIVE RADON-RESISTANT CONSTRUCTION

NEW RESIDENTIAL BUILDING CONSTRUCTION

9B-52.001 Purpose and intent.

9B-52.002 Definitions.

9B-52.003 Department activities.

9B-52.004 Florida Standard for Passive Radon-Resistant New Residential.

Building construction, adopted.

9B-52.001 Purpose and intent.

1. The provisions of this rule chapter are adopted to implement the *Florida Standard for Passive Radon-Resistant New Residential Building Construction* as mandated in Part X, Chapter 553, *Florida Statutes*, in order to provide standards for construction of passive radon-resistant new residential buildings and to provide for the public safety, health and general welfare.
2. These rules and regulations prescribe standards for radon-resistant construction of new residential buildings in Florida. However, none of the provisions contained herein, or in the standards adopted, shall preclude or prohibit the owners of such buildings from exceeding these standards at their discretion.
3. Local jurisdictions may enact ordinances for radon-resistant new residential building construction providing that a county governing authority and the governing bodies of the municipalities representing at least a majority of the county's municipal population enter into an interlocal agreement to adopt by ordinance the department's standard as referenced in Section 9B-52.004(1). The standard shall apply uniformly to all jurisdictions that adopt the standard. No local jurisdiction may adopt any requirement for radon-resistant building construction other than the standard.

Specific 553.98(1), 553.98(2) FS.

Law Implemented 553.98 FS.

History–New 9-1-96.

9B-52.002 Definitions. For the purpose of this rule chapter, the following words, unless the context does not permit such meaning, shall have the meanings indicated:

1. Department–The Department of Community Affairs.
2. Exempted buildings–
   a. Buildings of occupancy classifications other than one- or two-family detached houses and town house apartments with no more than three stories (as distinguished from condominiums, apartments or commercial buildings that employ different construction practices).
   b. Residential buildings built on piers or pilings that elevate the bottom of the floor joists a minimum of 18 inches (457 mm) above grade and which comply with all requirements of Section 103.2(2) of the *Florida Standard for Passive Radon-Resistant New Residential Building Construction*.
3. New residential building–One- or two-family detached houses and town house apartments with no more than three stories (as distinguished from condominiums, apartments or commercial buildings that employ different construction practices) for which a building permit is issued on or after the effective date of these rules.
4. Radon–A naturally occurring, chemically inert, radioactive gas. It is part of the Uranium-238 decay series, and is the direct decay product of Radium-226.
5. Standard–The *Florida Standard for Passive Radon-Resistant New Residential Building Construction*.

Specific 553.98(1) FS.

Law Implemented 553.98 FS.

History–New 9-1-96.

9B-52.003 Department activities.

1. The department shall interpret and clarify various aspects of the *Florida Standard for Passive Radon-Resistant New Residential Building Construction*.
2. Any person may request information or interpretations regarding the application and administration of the standards adopted herein, provided that any oral request shall be confirmed by the party in writing to the department prior to the department's response.

Specific 553.98(1), 120.53(1)(a) FS.

Law Implemented 553.98 FS.

History–New 9-1-96.

9B-52.004 Florida Standard for Passive Radon-Resistant New Residential Building Construction, Adopted.

1. The *Florida Standard for Passive Radon-Resistant New Residential Building Construction,* dated July 1, 1995, is herein incorporated by reference.
2. A copy of the above referenced standard has been filed with these regulations with the Secretary of State. The standard is also available for reference and inspection at the Department of Community Affairs, Division of Housing and Community Development, Radon Program, 2740 Centerview Drive, Tallahassee, Florida 32399-2100.

Specific 553.98(1) FS.

Law Implemented 553.98 FS.

History–New 9-1-96.

FLORIDA STANDARD FOR PASSIVE RADON-RESISTANT NEW RESIDENTIAL BUILDING CONSTRUCTION

July 1, 1995

State of Florida
Florida Department of Community Affairs
Radon Program
2555 Shumard Oak Blvd
Tallahassee, FL 32399-2100
Linda Loomis Shelley, Secretary

CHAPTER B101 GENERAL

B101 General. Provisions in the following chapters and sections shall constitute and be known as and may be cited as the *Florida Standard For Passive Radon-Resistant New Residential Building Construction*, hereinafter referred to as "this standard."

B102 Intent.

B102.1 General. This standard shall apply to the design and construction of new residential buildings as determined in Section B103, Scope, to enable control of human exposure to indoor radon and its progeny.

B102.2 Compliance. This passive standard will provide radon protection beyond that provided by standard building code provisions. Compliance with existing local building codes and with the *Florida Energy Efficiency Code for Building Construction*, current edition, is assumed.

B103 Scope.

B103.1 Applicability. The provisions of this standard shall apply to the construction of new residential buildings and additions to existing residential buildings. Residential buildings are defined for the purposes of this standard as one- or two-family detached houses and town house apartments with no more than three stories (distinguished from condominiums, apartments and commercial buildings that employ different construction practices).

B103.2 Additions. When the cost of an addition exceeds a cumulative total of 50 percent of the assessed value of the existing building, only the addition to the building must meet the requirements for new buildings in Section B104.1.

B104 Compliance.

B104.1 New buildings and additions. All new residential buildings and additions to existing residential buildings shall use passive radon protection measures, as determined in Chapter B3 of this standard.

B104.2 Exemptions. Exempt buildings are as follows:

1. Buildings of classifications not listed in Section B103.1, Applicability, and
2. Residential buildings built on piers or pilings that elevate the bottom of the floor joists a minimum of 18 inches (457 mm) above grade, which do not have skirting or stem walls that restrict air ventilation, and which comply with the following additional provisions:
   a. The perimeter of the building from the ground plane to the lower surface of the floor shall be totally open for ventilation, except for the occurrence of enclosures complying with item (c) below.
   b. All pilings, posts or other supports shall be solid, or if hollow, shall be capped by an 8 inch (203 mm) solid masonry unit or sealed by a permanent barrier that is impermeable to air flow.
   c. Enclosures of any kind, including chases, storage rooms, elevator shafts and stairwells, etc., that connect between the soil and the structure shall be sealed at the surface of the soil to comply with the sealing provisions of Chapter B3 and shall have a soil contact area of less than 5 percent of the total building floor area.

CHAPTER B201 DEFINITIONS

B201 General. For the purposes of this standard, certain abbreviations, terms, phrases, words and their derivatives shall be set forth in this chapter. Words not defined herein shall have the meanings stated in the *Florida Building Code, Building; Florida Building Code, Mechanical; Florida Building Code, Plumbing; Florida Building Code, Gas;* or *Florida Fire Prevention Code*. Words not defined in these codes shall have the meanings in *Webster's Ninth New Collegiate Dictionary*, as revised.

B202 Definitions.

ADDITION. A building extension or increase in floor area that can be occupied or that exchanges air with the conditioned space of the building.

AIR DISTRIBUTION SYSTEM. For the purposes of this standard, the air distribution system components which include ducts, plenums, air handlers, furnaces, single-package air conditioners, etc.

CAULKS AND SEALANTS. Those materials which will significantly reduce the flow of gases through small openings in the building shell. Among those used are:

Urethane. A crystalline ester-amide used as a gelatinizing agent for cellulose acetate or cellulose nitrate. A component of polyurethane used in making flexible and rigid foams, elastomers, and resins for coatings and adhesives.

Epoxy. A thermosetting resin characterized by adhesiveness, flexibility and resistance to chemicals and used chiefly as a coating or adhesive.

Polysulfide rubber. A synthetic rubber characterized by impermeability to gases and used in adhesives, binders and sealing compositions and in coatings.

CONDITIONED FLOOR AREA. The horizontal projection (outside measurements) of that portion of space which is conditioned directly or indirectly by an energy-using system.

CONDITIONED SPACE. All spaces which are provided with heated and/or cooled air or which are maintained at temperatures over 50ºF (10°C) during the heating season, including adjacent connected spaces separated by an uninsulated component (e.g., basements, utility rooms, garages, corridors).

CONTRACTION JOINT. A formed, sawed, or tooled groove in a concrete slab to create a weakened plane and control the location of cracking resulting from drying and thermal shrinkage (also sometimes called control joint).

CRAWL SPACE. The unconditioned space between the lowest structural member of the floor and the earth. The crawl space is created when the floor spans between structural supports rather than being directly supported by the earth beneath the floor.

ELASTOMERIC. That property of macromolecular material of returning rapidly to approximately the initial dimensions and shape, after substantial deformation by a weak stress and release of stress.

HIGH RANGE WATER REDUCER. A chemical admixture added to the concrete capable of reducing the water content at least 12 percent. This admixture shall conform to ASTM C 494 Type F or G.

HVAC. Heating, ventilating and air conditioning.

INFILTRATION BARRIER. A product or system designed to limit the free passage of air through a building envelope component (wall, ceiling or floor). Such products and systems may be continuous or noncontinuous discrete elements which are sealed together to form a continuous barrier against air infiltration.

MANUFACTURED SANDS. Sands resulting from the crushing of rock, gravel or slag.

MASTIC. A sealant with putty-like properties.

MIDRANGE WATER REDUCER. A water reducing admixture capable of reducing water content from 6 to15 percent. This admixture shall conform to ASTM C 494 Type A and or F.

MITIGATE. Make less severe, reduce, relieve.

NATURAL SANDS. Sands resulting from the natural disintegration and abrasion of rock.

OCCUPANCY. The purpose for which a building or part thereof is used or intended to be used. For the purposes of determining changes of occupancy for this code, the occupancy shall be considered the major occupancy group designations established by the locally adopted building code.

OUTSIDE AIR. Air taken from the outdoors and, therefore, not previously circulated through the system.

PASSIVE RADON PROTECTION SYSTEM. Indoor radon reducing building design, material, or construction features that increase the barriers to radon entry and require no mechanical operation, operating costs, or user attention beyond normal home maintenance (such as recaulking floor cracks, etc.)

PERM. Unit of measurement of the water vapor permeance of materials. Value of one perm is equal to one grain of water vapor per square foot hour per inch of mercury vapor pressure difference.

PICOCURIE (pCi). A unit of measurement of radioactivity. A curie is the amount of any radionuclide that undergoes exactly 3.7 x 1010 radioactive disintegrations per second. A picocurie is one trillionth (10^{-12}) of a curie, or 0.037 disintegrations per second.

PICOCURIE PER LITER (pCi/L). A common unit of measurement of the concentration of radioactivity in a gas. A picocurie per liter corresponds to 0.037 radioactive disintegrations per second in every liter of air.

RADIUM (Ra). A naturally occurring radioactive element resulting from the decay of uranium. For the purposes of this standard, radium applies to Radium-226. It is the parent of radon gas.

RADON. A naturally occurring, chemically inert, radioactive gas. It is part of the Uranium-238 decay series. For the purposes of this standard, radon applies to Radon-222; thus, it is the direct decay product of Radium-226.

REMOTE SPACE. A space isolated from the main conditioned area of a building by intermediate non-conditioned spaces.

RESIDENTIAL BUILDING. A residential occupancies which include single-family and multiple-family buildings that are three or fewer stories above grade. Hotels, motels and other transient occupancies are considered nonresidential buildings for the purpose of this standard.

SLUMP. A measure of the relative consistency or stiffness of fresh concrete mix, as defined by ASTM C 143.

SOIL GAS. Gas which is always present underground, in the small spaces between particles of the soil or in crevices of rock. Major constituents of soil gas include air and water vapor. Since Radium-226 is essentially always present in the soil or rock, trace levels of Radon-222 also will exist in the soil gas.

SUBSTRUCTURE MEMBRANE. Flexible, nondegrading material sheet placed between the soil and the building for the purpose of reducing the flow of soil gas and moisture into the building. Examples are: polyethylene, ethylenepropylene diene terpolymer (EPDM), neoprene, and cross laminated HDPE.

VENTILATION. The process of supplying or removing air, by natural or mechanical means, to or from any space. Such air may or may not have been conditioned.

WATER-REDUCING ADMIXTURE. A chemical additive to concrete capable of increasing its flowability without increased mixing water, without set retardation, and without increased air entrainment.

CHAPTER B301
CONSTRUCTION REQUIREMENTS FOR PASSIVE RADON CONTROL

B301 General. This chapter provides minimum design and construction criteria for passive control of radon entry into residential buildings. Construction to these standards will limit radon entry points through building floors and foundations and will limit mechanical depressurization of buildings which can enhance radon entry.

B302 Sub-slab and soil membranes.

B302.1 Membrane material. A sub-slab or soil-cover membrane shall consist of a minimum 0.006 inch (0.152 mm) (6 mil) thick single layer of polyethylene. Polyvinylchloride (PVC), ethylene propylene diene terpolymer (EPDM), neoprene or other nondeteriorating nonporous material may be used instead of polyethylene, provided the installed thickness has greater or equal resistance to air flow, puncturing, cutting and tearing, and a permeance of less than 0.3 perm as determined in accordance with ASTM E 96. The membrane shall be placed to minimize seams and to cover all of the soil below the building floor.

B302.2 Tape. Tape used to install the membrane shall have a minimum width of 2 inches (51 mm) and shall be pressure sensitive vinyl or other nondeteriorating pressure sensitive tape compatible with the surfaces being joined. Paper tape and/or cloth shall not be used for these purposes.

B302.3 Mastic. Mastic used to install the membrane shall be compatible with the surfaces being joined, and shall be installed in accordance with the manufacturer's recommendations for the materials, surface conditions and temperatures involved. Mastic may be used to join sections of membrane to one another or to elements of the building foundation, or to seal penetrations in the membrane.

B302.4 Installation. The membrane shall be placed under the entire soil-contact area of the floor in a manner that minimizes the required number of joints and seams. Care shall be taken to prevent damage to the membrane during the construction process.

B302.5 Seams. Seams between portions of the membrane shall be lapped a minimum of 12 inches (305 mm) and shall be secured in place with a continuous band of tape or mastic centered over the edge of the top membrane.

B302.6 Slab edges and joints. The membrane shall fully cover the soil beneath the building floor. Where the slab edge is cast against a foundation wall or grade beam, the membrane shall contact the foundation element, and shall not extend vertically into the slab more than one inch.

B302.7 Penetrations, punctures, cuts and tears. At all points where pipes, conduits, stakes, reinforcing bars or other objects pass through the membrane, the membrane shall be fitted to within $^1/_2$ inch (12.7 mm) of the penetration and sealed to the penetration. Penetrations may be sealed with either mastic or tape. When necessary to meet this requirement, a second layer of the membrane, cut so as to provide a minimum 12 inches (305 mm) lap on all sides, shall be placed over the object and shall be sealed to the membrane with a continuous band of tape.

B302.8 Repairs. Where portions of an existing slab have been removed and are about to be replaced, a membrane shall be carefully fined to the opening and all openings between the membrane and the soil closed with tape or mastic.

B303 Floor slab-on-grade buildings.

B303.1 General. All concrete slabs supported on soil and used as floors for conditioned space or enclosed spaces connected or adjacent to a conditioned space shall be constructed in accordance with the provisions of Sections B302 and B303.

B303.2 Slab edge detail. Slabs and foundations shall be constructed using a slab edge detail that eliminates cracks that could connect the house interior to subslab soil and is consistent with other construction constraints such as terrain. Monolithic slab construction should be used where possible. Only the following slab edge detail options may be used:

1. Thickened edge monolithic–The subslab membrane shall extend beyond the outside face of the slab edge.
2. Slab poured into stem wall–Where concrete blocks are used as slab forms, the subslab membrane shall extend horizontally at least 1 inch (25.4 mm) into the stem wall, but shall not extend upward along any vertical faces of the stem wall. The concrete slab shall be poured into the stem wall to completely fill its open volume to form a continuous and solid stem wall cap of minimum 8 inch (203 mm) thickness. Framed exterior walls shall be sealed or gasket to the slab.
3. Slab capping stem wall–Where the floor slab is formed and placed to completely cover the stem wall, the subslab membrane shall extend horizontally beneath the slab to its outer edge. The supporting stem wall shall be capped with a solid masonry unit of at least 4 inch (102 mm) thickness beneath the membrane and the slab.

B303.3 Sealing of joints, penetrations and cracks in slabs.

B303.3.1 Contraction joints. All contraction joints shall be cleaned and sealed against soil-gas entry by use of an approved sealant (see Section B303.6) applied according to the manufacturer's instructions. (Note: most sealants require the concrete to be cured and dried.) For bottom-induced joints, inverted T-split ribbed waterstops at least 6 inches (152 mm) wide made of impermeable material may be formed into the slab and shall not require top-surface sealing for radon control.

B303.3.2 Horizontal joints. Horizontal joints between two slabs of different elevations that are poured at different times shall provide horizontal contact between the two slabs that is at least 8 inches (203 mm) wide, or shall be sealed by an approved sealant (Section B303.6).

B303.3.3 Vertical joints through slabs. Vertical joints through slabs shall be formed with a recess of not less than $^1/_4$ inch by $^1/_4$ inch (6.4 mm by 6.4 mm) and sealed with an approved sealant.

Exception: Slabedge vertical joints occurring in slab poured into stem wall construction [see Section B303.2(2)]. The sealant (see Section B303.6) shall be applied according to the manufacturer's instructions. (Note: most sealants require the concrete to be cured and dried.)

B303.3.4 Penetrations.

B303.3.4.1 Stake penetrations. Any stake that extends through more than one-fourth the thickness of the slab shall be of a nonporous material resistant to decay, corrosion and rust, and shall be cast tightly against the slab, or sealed to the slab in accordance with Section B303.6. All stakes shall either be solid, or shall have the upper end tightly sealed by installation of an end cap designed to provide a gas-tight seal.

B303.3.4.2 Work spaces. Work spaces formed into a slab, such as beneath a shower or bath tub drain, shall be sealed gas tight. The exposed soil shall be compacted and then shall be fully covered with a solvent-based plastic roof cement or a foamed-in-place polyurethane sealant or other approved elastomeric material to a minimum depth of 1 inch (25.4 mm).

B303.3.4.3 Pipe penetrations. Plastic pipes shall be in contact with the slab along the slab's depth by casting the concrete tightly against the pipe. Where pipes are jacketed by sleeves they shall be sealed by one of the following methods:

1. Formation of a slot in the slab around the pipe and casting with asphalt or an approved sealant from the slab to a point above the sleeve, or
2. Seal the space between the sleeve and the pipe with an appropriate joint sealant (see Section B303.6).
3. Pipes and wiring penetrating the slab through chases or conduit shall be sealed by placing an approved sealant between the pipe or wiring and chase or conduit. Plastic sheath, foam or insulation material shall not be used alone around pipes or conduit for sealing purposes.
4. Where multiple pipes are ganged, block out a work space around the multiple pipes and seal as in Section B303.3.4.2.

B303.3.5 Cracks. All slab cracks greater than $^1/_{32}$ inch (0.8 mm) wide; all cracks that exhibit vertical displacement; all cracks that connect weakened zones in the slab such as vertical penetrations or re-entrant corners; and, all cracks that cross changes in materials or planes in the structure, shall be cleaned and sealed against radon entry, prior to applying floor covering, with a flexible field-molded elastomeric sealant installed in accordance with Section B303.6. Cracks less than $^1/_{32}$ inch (0.8 mm) in width that do not meet any of the above criteria may be left unsealed.

B303.4 Concrete for slabs.

B303.4.1 Mix design. Mix designs for all concrete used in the construction of slab-on-grade floors shall specify a minimum design strength of 3,000 psi (20.7 MPa) at 28 days and a design slump not to exceed 4 inches (102 mm). On-site slumps shall not exceed 5 inches (127 mm), provided total water added to the mix including plant, transit and site added water does not exceed the following parameters:

1. For mixes using natural sands–275 pounds per cubic yard [33 gallons (125 L)].
2. For mixes using manufactured sands–292 pounds per cubic yard [35 gallons (132.5 L)].

B303.4.2 Concrete placement. For improved workability of concrete used in the construction of slab-on-grade floors, additional water and/or water-reducing admixtures shall be wed within the following constraints:

1. Slumps in excess of 5 inches (127 mm) shall be achieved through the use of midrange or high-range water reducing admixtures. Water shall not be used in excess of the limitations.
2. Slumps of concrete containing midrange or high range water reducing admixtures shall not exceed 8 inches (203 mm).

B303.4.3 Curing. Concrete slabs shall be cured continuously after pouring according to one of the following procedures:

1. Moist curing by means of ponding, fog spray or wet burlap for at least seven days.
2. Moist curing using impermeable cover sheet materials conforming with ASTM C l71 for at least seven days.
3. Curing with liquid membrane forming compound according to manufacturer's specifications and conforming with ASTM C 309.

Curing compounds shall be compatible with materials specified in Section B303.6.

B303.4.4 Loading. Loading or use of the slab shall be delayed for a minimum of 48 hours after concrete placement. When the slab is used for material storage after the minimum 48-hour period, caution should be used to prevent impact loading.

B303.4.5 Slab reinforcement. Floor slabs shall be reinforced by steel reinforcing bars at reentrant corners such as inside corners of an L-shaped slab. Reentrant corners shall have two pieces of #4 reinforcing bar 36 inches (914 mm) long placed diagonally to the corner, 12 inches (305 mm) apart, with the first bar placed 2 inches (51 mm) from the corner. All reinforcement shall be appropriately positioned in the upper third of the slab.

B303.5 Sealing walls. Penetrations for electrical receptacles and switches, wiring, plumbing, etc. in the interior surface of the concrete block walls shall be sealed.

B303.6 Approved sealant material. Acceptable polyurethane, polysulfide and epoxy caulks and sealants shall conform with ASTM C 920-87, *Standard Specifications for Elastomeric Joint Sealants*, and ASTM C 1193-91, *Standard Guide for Use of Joint Sealants*. Sealant material and the method of application shall be compatible with curing compounds, admixtures and floor finishing materials; withstand light traffic; be impermeable to soil gas; and have an allowable extension and compression of at least 25 percent with 100 percent recovery. Sealants shall be applied to dried and cured concrete in accordance with manufacturers' instructions. Backer rods may be used to support sealants in cracks and joints.

B304 Slab-below-grade construction.

B304.1 General. For the purposes of this standard, slab-below-grade construction is defined as any conditioned space with the finished floor below finished grade at any point.

B304.2 Slab construction. Slabs shall have a sub-slab membrane, conforming with Section B302 that extends to the slab perimeter, but does not vertically separate the slab from the foundation wall. The slab and membrane shall be placed in accordance with Section B303, or may use a floating slab design with all of the following conditions:

1. The stem wall is solid poured concrete.

2. The slab-wall joint is tooled and sealed with flowable polyurethane (according to Section B303.6).
3. All other provisions of Section B303 are satisfied.

B304.3 Sealing walls.

B304.3.1 Walls. Walls surrounding slab-below-grade space shall be constructed from solid poured concrete, at least 8 inches (203 mm) thick, and shall be sealed with a continuous waterproofing coating applied to their outside surface from the top of the footing to finished grade. This coating shall completely seal any joint between the footing and the wall.

B304.3.2 Utility penetrations. All utility penetrations through walls in partial or full contact with the soil shall be closed and sealed with an approved sealant material (see Section B303.6) on the interior and exterior faces of the wall.

B304.4 Sumps. Any sump located in a habitable portion of a building, or in an enclosed space directly attached to a portion of a building, shall be covered by a lid. An air tight seal shall be formed between the sump and lid and at any wire or pipe penetrations.

B305 Buildings with crawl spaces.

B305.1 General. For the purposes of this standard, buildings with crawl spaces include all buildings with floor supported above grade which do not meet the requirements of Section B306.

B305.2 Floor systems. Reinforced concrete floors constructed over crawl spaces shall conform to all applicable provisions of Section B303. Wood-framed floors constructed over crawl spaces shall include an air infiltration barrier in compliance with Chapter 13 of the *Florida Building Code, Building*, current edition. All joints and penetrations through the floor, including plumbing pipes, conduits, chases, wiring, ductwork and floor-wall joints, shall be fully sealed with an approved caulk. Where large openings are created (such as at bathtub drains), sheet metal or other rigid materials shall be used in conjunction with sealants to close and seal the openings.

B305.3 Crawl space ventilation. Screened vents without closures shall be installed around the perimeter of the house to connect the crawl space with outdoor air.

B305.3.1 Vent area. The crawl space vents shall have a total area equal to either:

1. At least $^1/_{150}$ of the area enclosed by the crawl space if the crawl space is exposed to bare soil; or
2. At least $^1/_{300}$ of the area enclosed by the crawl space if the crawl space is completely covered by a substructure membrane.

B305.3.2 Ventilation obstructions. The crawl space shall not contain structures that restrict ventilation in the crawl space. If freeze protection is provided for plumbing in the crawl space, the protection shall not restrict air ventilation in the crawl space.

B305.4 Sealing walls and doors. Penetrations from the crawl space into wall cavities shall be fully sealed with an approved caulk or sealant. When a door is located between the crawl space and the conditioned space, it shall be fully weatherstripped or gasketed.

B305.5 Closing and sealing other paths. Any openings that connect a crawl space and the closed space between floor or ceiling joists, wall studs, or any other cavity adjoining conditioned space shall be closed and sealed.

B305.6 Soil connection. Foundation walls and piers or other intermediate supports that intersect the floor plane shall be solid across the entire horizontal section at a point above the ground plane.

B306 Buildings with combination floor systems.

B306.1 Floor system construction. Where slab-on-grade, slab below-grade, crawl space or elevated building construction are combined in one structure, the provisions for each construction type shall be met.

B306.2 Walls. A wall located between a crawl space and conditioned space shall be designed and constructed in compliance with Chapter 13 of the *Florida Building Code, Building*, current, and the provisions of the applicable Sections B303 through B305 of this standard.

B307 Space conditioning systems.

B307.1 Equipment enclosures.

B307.1.1 Crawl spaces. Return ducts, return plenums and air handlers shall not be located in crawl spaces. Crawl spaces shall not be used as supply or return plenums.

B307.1.2 Condensate drains, piping and wiring chases. Condensate drain pipe joints shall be sealed (chemical weld, soldered, etc.) gas tight and shall terminate outside the building perimeter at a height of at least 6 inches (152 mm) above the finished grade ground level. Chases through which the condensate and refrigerant lines run shall not terminate in the return sections of the air distribution system. Where chase lines terminate within the house or garage, they shall be sealed.

B307.2 Air distribution systems.

B307.2.1 Sealing. All ducts and plenums shall be made air tight, constructed and installed in accordance with the current edition of Chapter 13 of the *Florida Building Code, Building* for building construction. Where rigid fibrous glass ductboard is used, the seal must be on the foil air barrier side of the ductboard.

B307.2.2 Return plenums and ducts. Return air shall be separated from any floor that is in contact with the soil or a crawl space, by a plenum or duct fabricated in compliance with Section B307.2.1 and all local codes. Construction of the return plenum or duct shall provide a continuous air barrier that completely separates the depressurized plenum or duct from adjacent building components including but not limited to floors, walls, chases, enclosures, etc. The support platform shall not be used as a return plenum. Where the support platform provides a protective enclosure for a duct, one side shall have a removable panel or door to provide access for inspection and/or repair of the duct and duct-to-air handler connection. Ducts shall carry the return air from the return grills or return plenums to the air handler and shall have a positive air-tight seal to the air handler. A closet shall not be used as a return plenum.

B307.2.3 Return grille connection. The return pathway from the return grille shall be a part of the return duct or plenum and shall have a continuous air barrier along its boundary. Where the return pathway passes through a wall cavity, the cavity shall be sealed around the duct in all directions to prevent the leakage of air into the return air stream.

B307.2.4 Location of ducts and plenums. Supply and return ducts shall not be located below concrete slab-on-grade floors, and return ducts and plenums shall not be located in crawl spaces.

B307.3 Exhaust fans.

B307.3.1 Bathroom fans. Bathroom exhaust fans shall be controlled by an independent separate switch. Manually operated timers should be used as applicable.

B307.3.2 Attic fans. If used, attic exhaust fans shall be installed with unobstructed vent and intake areas in accordance with the minimum areas prescribed by their manufacturer. In no case shall effective open vent area be less than the minimum areas prescribed by the manufacturer.

APPENDIX C

CHAPTER 9B-53 F.A.C
STANDARD FOR MITIGATION OF RADON IN EXISTING BUILDINGS

9B-53.001 Purpose and intent. (Repealed)

9B-53.002 Definitions.

9B-53.003 Department activities.

9B-53.004 Florida Standard for Mitigation of Radon in Existing Buildings, Adopted.

9B-53.001 Purpose and Intent.
Specific Authority 553.98(1) FS.
Law Implemented 553.98 FS.
History–New 2-26-91, Repealed 2-20-96.

9B-53.002 Definitions.

For the purpose of this rule chapter, the following words, unless the context does not permit such meaning, shall have the meanings indicated:

1. Department–The Department of Community Affairs.
2. Exempted Buildings–Structures not intended for human occupancy.
3. Existing Building–Any structure erected prior to the adoption by the local government of the building code presently enforced in that jurisdiction, and which has been issued a certificate of occupancy or has been legally occupied.
4. Radon–A naturally occurring, chemically inert, radioactive gas. It is part of the Uranium-238 decay series, and is the direct decay product of Radium-226.
5. Standard–The *Florida Standard for Mitigation of Radon in Existing Buildings*.

Specific 553.98(1) FS.
Law Implemented 553.98 FS.
History–New 2-26-91.

9B-53.003 Department activities.

1. The department may interpret and clarify various aspects of the *Florida Standard for Mitigation of Radon in Existing Buildings*. The department will promulgate such rules and regulations as will from time to time be deemed necessary to carry out its purpose.
2. The department shall provide training on the use of the standard.
3. Within two years of the date of adoption of the standard, and at least biennially thereafter, the department shall update and adopt standards based on the most current research. Any person may submit recommendations for proposed revisions or modifications to the standard to the department for consideration. Such proposed revisions and modifications shall be submitted in writing on Department of Community Affairs Form #200, the "Proposed Code Change Request" form, incorporated herein by reference, effective 1991. Such proposals shall include an identification of the section of the standard to be revised, the new proposed language, and a justification or reason for the change. The department shall conduct a public hearing(s) in accordance with the requirements of Chapter 120, F.S. Proposed revisions or modifications deemed necessary and appropriate by the department shall then be adopted for implementation pursuant to Chapter 120, F.S., and Section 553.98, F.S.
4. The department may contract for supplemental consulting services necessary for performance of its duties.
5. Any person may request information or interpretations regarding the application and administration of the standards adopted herein, provided any oral request is later confirmed by the party to the department in writing.
6. The department shall collect such data as necessary to evaluate the effectiveness and extent of implementation of this standard.

Specific 553.98(1), 120.53(1)(a) FS.
Law Implemented 553.98 FS.
History–New 2-26-91.

9B-53.004 Florida Standard for Mitigation of Radon in Existing Buildings.

1. The June 1994 edition of the *Florida Standard for Mitigation of Radon in Existing Buildings*, that edition of the standard having an effective date of June 1, 1994, is herein incorporated by reference. The department shall revise, update and maintain the Florida *Standard for Mitigation of Radon in Existing Buildings*.
2. A copy of the above referenced standard as amended has been filed with these regulations with the Secretary of State. The standard is also available for reference and inspection at the department offices in Tallahassee, Division of Housing and Community Development.

Specific 553.98(1) FS.
Law Implemented 553.98 FS.
History–New 2-26-91, Amended 5-10-94.

FLORIDA STANDARD FOR MITIGATION OF RADON IN EXISTING BUILDINGS

Effective: June 1, 1994

Introduction

Radon is a radioactive gas which occurs naturally in soils. It has been found in high concentrations in some areas of many states including Florida. Radon can enter buildings through floor cracks and openings driven by pressure differences which result from space conditioning and ventilation systems, temperatures and wind. Its radioactive decay products can cause lung cancer when inhaled.

The following building standards have been developed in accordance with Section 553.98, Florida Statues to protect the public by setting standards for mitigation of radon concentrations in existing buildings.

Principal Approaches for Radon Mitigation in Existing Buildings.

This building standard addresses five principal approaches to mitigating radon accumulation in buildings:

1. Radon control using the building structure as a gas barrier. This is a passive approach which requires no fans (see Chapter 4).
2. Radon control by lowering the air pressure in the soil beneath the building relative to the indoor air pressure of the building. This is an active approach which requires one or more electrically driven fans (see Chapter 6).
3. Radon control by raising the indoor air pressure in the building relative to the air pressure in the soil beneath the building. This is an active approach which may either use an existing heating and air-conditioning system blower or an additional electrically driven fan. This approach may have significant negative impact on the annual energy consumption of the building due to heating and cooling of additional outdoor air in addition to fan power consumption (see Chapter 5).
4. Radon control by ventilating the building with outdoor air. This is an active approach which may either use an existing heating and air-conditioning system blower or an additional electrically driven fan. This approach may have significant negative impact on the annual energy consumption of the building due to heating and cooling of additional outdoor air and to increased fan power consumption (see Chapter 5).
5. Radon control by separating the building and source with a ventilated region of outside air. This approach is generally applicable to buildings with a crawl space, and may be either active or passive (see Chapter 6).

The standard does not mandate the implementation of any of the principal approaches listed above. It establishes minimum standard practices for each of the principal approaches. Implementation of these minimum standard practices does not guarantee successful mitigation. A post mitigation indoor radon concentration test must be conducted to demonstrate successful mitigation in compliance with the rules of the Department of Health and Chapter 3 of this standard.

FOREWORD

The practices incorporated in the standard are based on experience, testing, and in certain cases expectations founded on interpretation of fundamental physical principles. The demonstration at successful mitigation utilizing the different approaches incorporated in this standard varies.

Subslab depressurization, crawlspace ventilation, and submembrane depressurization have the highest demonstrated success rates. Success with these approaches has in many cases required modification and enhancement of systems based on post mitigation indoor radon tests.

Effective sealing of accessible entry points has been demonstrated to make a significant impact on indoor radon concentrations. However, mitigation by sealing entry points alone has not had a demonstrated level of success equivalent to the aforementioned active mitigation systems. This is understood to be principally because of the difficulty in locating and treating enough entry points to resist the driving forces which cause radon laden soil gas and crawlspace air entry. The significance of entry points and their treatment can be ranked based on their size, location and the degree of depressurization of the building space surrounding them. Design and construction of successful subslab depressurization systems also depends on entry point size, location and the magnitude of coincident building depressurization. Attention to limiting entry at points of high depressurization such as space conditioning system return plenums, mechanical closets, etc., is critical to the success of both passive mitigation and minimally designed active mitigation systems.

Building pressurization is expected, based on fundamental principles, to provide a potentially effective mitigation strategy. The effectiveness for individual cases may rely on occupant behavior as well as building leakage characteristics. Pressurization systems also have potentially major impacts on occupant comfort, humidity control and energy use.

Building ventilation has potential application where low indoor radon concentrations exist initially. This approach can have significant impacts on the ability of a building's climate control systems to perform adequately in the hot and humid climate and on energy consumption for comfort conditioning.

None of the techniques in this standard are guaranteed to provide adequate mitigation. The complexities of existing buildings and the inherent limitations in the ability to determine the building's construction characteristics result in conditions too diverse for a standard to anticipate. Successful mitigation depends on the experience of the mitigator to make an effective selection of mitigation options. A post mitigation indoor radon test is essential for determining if initial mitigation has been successful. Proper maintenance and operation of mechanical systems implemented as part of active mitigation approaches are critical to the long term effectiveness of mitigation where such systems are used. Periodic retests of indoor radon concentrations at least every two years, and when the building undergoes significant structural alterations, are advised for all mitigation approaches to provide continued assurance of safe indoor radon levels.

TABLE OF CONTENTS

CHAPTER C101
ADMINISTRATION

C101 General.

C101.1 Title. Provisions in the following chapters and sections shall constitute and be known as, and may be cited as, the Florida *Standard For Mitigation of Radon in Existing Buildings,* hereinafter referred to as "this standard."

C101.2 Intent.

C101.2.1 General. This standard applies to those alterations to existing buildings that are implemented to reduce indoor radon concentrations, in order to enable control of human exposure to indoor radon and its progeny.

C101.2.2 Limits. This standard is intended to improve indoor air quality with respect to radon. These standards are based on the principle of limiting radon concentrations to levels as low as reasonably achievable, within the limitations at current technology and economic feasibility. Use of this standard does not guarantee radon will be limited to any specific concentrations in a building; however, experience indicates a reduction in radon and its progeny can be realized by using the mitigation strategies described in this standard.

C101.2.3 Durability. Experience with the radon-resistant construction details contained herein has been limited to a fraction of the average life of a building. Implementation of radon mitigation measures described herein does not guarantee that mitigation effects will be permanent. Periodic inspection and maintenance of the radon mitigation measures and retesting of indoor radon levels is the responsibility of the building owner.

C101.3 Scope.

C101.3.1 Applicability. The provisions of this standard shall apply to the construction or alteration associated with the mitigation of indoor radon in every building or structure not specifically exempted. Exempted occupancies shall include structures not intended for human occupancy.

C102 Alternate materials and methods. The provisions of this standard are not intended to prevent the use of any material or method of construction not specifically prescribed by this standard, provided any such alternate is demonstrated according to the provisions of Chapter C3 of this standard, to be effective at the control of radon.

C103 Compliance. All mitigation shall be deemed to be in compliance with this standard when: (a) the techniques utilized in mitigation meet the minimum standard practices established herein; and (b) the building is determined to meet the "not to exceed" exposure standard established by the DOH or the level specified in any warranty or guarantee provided to the client. The DOH has set an exposure standard for radon decay products in buildings at an annual average of 0.02 working levels. Under conditions often encountered in homes, this is equivalent to an annual average radon level of 4.0 picoCuries per liter. Radon levels in most buildings can be reduced to 4.0 picoCuries per liter or below.

Testing must be conducted in accordance with all applicable sections of the DOH *Florida Administrative Code,* Chapter 64E-5 and in accordance with Chapter C3 of this standard.

CHAPTER C201
DEFINITIONS

C201 General. For the purposes of this standard, certain abbreviations, terms, phrases, words and their derivatives shall be set forth in this chapter. Where terms are not defined therein, they shall have the meaning as noted in the applicable locally adopted code. Words not defined in any locally adopted code shall have the meanings in *Webster's Ninth New Collegiate Dictionary*, as revised.

C202 Definitions.

AUTOMATIC. Self-acting, operating by its own mechanism when activated by some personal influence, as for example, a change in current, pressure, temperature or mechanical configuration.

CAULKS AND SEALANTS. Those materials which will significantly reduce the flow of gases through small openings in the building shell. Among those used are:

Urethane. A crystalline ester-amide used as a gelatinizing agent for cellulose acetate or cellulose nitrate. A component of polyurethane used in making flexible and rigid foams, elastomers, and resins for coatings and adhesives.

CONDITIONED SPACE. All spaces which are provided with heated and/or cooled air or which are maintained at temperatures over 50°F (10°C) during the heating season, including adjacent connected spaces separated by an uninsulated component (e.g. basements, utility rooms, garages, corridors).

CONTRACTOR. A building trades professional licensed by the state, including certified mitigation business.

CRAWL SPACE. An area beneath the living space in some houses, where the floor of the lowest living area is elevated above grade level. This space (which generally provides only enough head room for a person to crawl in), is not living space, but often contains utilities.

DEPRESSURIZATION. A condition that exists when the measured air pressure is lower than the reference air pressure.

ELASTOMERIC. That property of macromolecular material of returning rapidly to approximately the initial dimensions and shape, after substantial deformation by a weak stress and release of stress.

Mil - 1 mil = 1/1000 of an inch

MITIGATION. The act of making less severe, reducing or relieving. For the purposes of this standard, a building shall not be considered as mitigated until it has been demonstrated to meet the standards of compliance specified in Section 103.

OUTSIDE AIR. Air taken from the outdoors and, therefore, not previously circulated through the system.

PICOCURIE (pCi). A unit of measurement of radioactivity. A curie is the amount of any radionuclide that undergoes exactly 3.7 x 1010 radioactive disintegrations per second. A picocurie is one trillionth (10-12) of a curie, or 0.037 disintegrations per second.

PICOCURIES PER LITER (pCi/l). A common unit of measurement of the concentration of radioactivity in a gas. A picocurie per liter corresponds to 0.037 radioactive disintegrations per second in every liter of air.

RADIUM (Ra). A naturally occurring radioactive element resulting from the decay of Uranium. It is the parent of radon.

RADON (Rn). A naturally occurring, chemically inert, radioactive gas. It is part of the Uranium-238 decay series, it is the direct decay product of Radium-226.

SOIL DEPRESSURIZATION SYSTEM. A system designed to withdraw air below the slab through means of a vent pipe and fan arrangement (active).

SOIL GAS. Gas which is always present underground, in the small spaces between particles of the soil or in crevices in rock. Major constituents of soil gas include nitrogen, water vapor, carbon dioxide, and (near the surface) oxygen. Since Radium-226 is essentially always present in the soil or rock, varying levels of Radon-222 will exist in the soil gas.

SOIL GAS RETARDER. A concrete slab; polyvinylchloride (PVC) ethylenepropylene dieneterpolymer (EPDM), neoprene or other flexible sheet material; or other system of materials placed between the soil and the building for the purpose of reducing the flow of soil gas into the building.

VENTILATION. The process of supplying or removing air, by natural or mechanical means, to or from any space. Such air may or may not have been conditioned.

CHAPTER C301
TESTING

C301 General. Where mitigation projects are performed by commercial mitigation contractors, all tests performed to demonstrate compliance with this standard must be performed by a certified radon measurement business certified by the Florida Department of Health and Rehabilitative Services. Compliance tests must be performed by a measurement business independent of the mitigation contractor.

C301.1 Test procedures. Testing shall be conducted according to the procedures in the appropriate sections of EPA 402-R-92-004, *Indoor Radon and Radon Decay Product Measurement Device Protocols* (US EPA, July, 1992) and EPA 402-R-92-003, *Protocols for Radon and Radon Decay Product Measurements in Homes* (USEPA, June 1993).

C301.2 Acceptable devices and test periods. Selection of devices, operational devices, and test periods shall be in accordance with EPA 402-R-92-004.

C301.2.1 Acceptance criteria. The building will be deemed to comply with the standard if post mitigation test results performed in accordance with this chapter and all applicable sections of Chapter 64E-5, *Florida Administrative Code*, Part XII, Subpart A, meet the "not to exceed" exposure standard established by the DOH or the level specified in any warranty or guarantee to the client.

CHAPTER C401
STRUCTURAL SEALING AND HVAC SYSTEM BALANCING

C401 General. When accessible cracks, penetrations, and joints in floors and walls in contact with the soil, or separating conditioned space from a crawl space, are sealed to reduce radon entry, they shall as a minimum be sealed in accordance with the provisions of this chapter. In addition, when acceptable indoor radon concentrations are attained by the sealing of ducts and plenums, they shall be done in accordance with the provisions of this chapter.

C402 Sealing cracks and joints in concrete floors and walls.

C402.1 Small cracks and joints. Cracks and joints with widths less than $^1/_{16}$ inch (1.6 mm) shall be repaired by the application of an elastomeric material capable of withstanding at least 25 percent extension and extending at least 4 inches (102 mm) beyond the length and width of the crack, or by the method described in Section C402.2.

C402.2 Large cracks and joints. Cracks with widths larger than $^1/_{16}$ inch (1.6 mm) shall be enlarged to a recess with minimum dimensions of $^1/_4$ inch by $^1/_4$ inch (6.3 mm by 6.3 mm) and sealed with an approved caulk or sealant applied over a sealant backer in accordance with the manufacturer's recommendations. Cracks and joints with widths less than $^1/_{16}$ inch (1.6 mm) may also be sealed in this manner if traffic, floor covering material or other conditions are inconsistent with the provisions of Section C402.1.

C402.3 Utility penetrations, work spaces and large slab openings. Where large openings through the slab exist, such as at a bath tub drain or a toilet flange, an acceptable method for sealing the exposed soil shall include fully covering the exposed soil with a solvent based plastic roof cement or other approved material as per Section C405.1 to a minimum depth of 1 inch (25 mm). Where voids between masonry foundation walls and the slab edge are accessible, and are sealed in order to reduce radon entry, nonshrinking cementitious material may be used.

C402.4 Utility penetrations in crawl space walls. Utility penetrations or other openings through hollow cavity walls that separate conditioned space from soil, or conditioned space from a crawl space, shall be sealed with an approved material on both the interior and exterior faces of the wall. Penetrations and openings through solid concrete floors or walls may be sealed on only the interior face.

C402.5 Hollow masonry walls. All openings for electrical boxes or plumbing or other wall penetrations in hollow masonry walls, that are sealed in order to reduce radon entry, shall be sealed with an approved caulk and/or gasket on the interior face of the wall.

C402.6 Sumps. Any sump located in a conditioned portion of a building, or in an enclosed space directly attached to a conditioned portion of a building, shall be covered by a lid. An air tight seal shall be formed between the sump and lid and at any wire or pipe penetrations.

C403 Floors over crawl space.

C403.1 Reinforced concrete floors. Cracks and penetrations through concrete floors constructed over crawl spaces, and that are sealed in order to reduce radon entry, shall be sealed in conformance with all applicable provisions of Section C402.

C403.2 Wood-framed floors. All penetrations through the subfloor, including but not limited to plumbing pipes, wiring and ductwork, that are sealed in order to reduce radon entry, shall be sealed with an approved caulk in accordance with the manufacturer's recommendations. Where large openings are created by plumbing, such as at bath tub drains, sheet metal or other rigid and durable materials shall be used in conjunction with sealants to close and seal the opening.

C404 Combined construction types.

C404.1 Structural chases. Openings which connect a crawl space and the space between floor or ceiling joists, wall studs, or any other hollow chase adjoining conditioned space, that are sealed in order to reduce radon entry concentrations, shall be closed and sealed in accordance with the appropriate portions of this chapter.

C404.2 Wall penetrations. Openings for electrical or plumbing connections in a wall between a crawlspace and a conditioned space, that are sealed in order to reduce radon entry, shall be closed and sealed with an approved caulk and/or gasket.

C404.3 Doors. When a door is located in a wall between a crawlspace and the conditioned space, it shall be fully weatherstripped or gasketed.

C405 Approved sealant materials.

C405.1 Sealants. Acceptable caulks and sealants shall conform with ASTM C 920-87, *Standard Specifications for Elastomeric Joint Sealants* and ASTM C 962-86, S*tandard Guide for Use of Elastomeric Joint Sealants*. All sealant materials and methods of application shall be compatible with the location, function and material of the surface or surfaces being sealed.

C406 Space conditioning and ventilation systems.

C406.1 Mechanical system connections. Condensate drains and pipe chases for freon lines that provide a direct connection between the indoor air and the soil shall be sealed in accordance with the provisions of this section.

C406.1.1 Condensate drains. Condensate drains shall connect to air outside the building perimeter at a height of at least 6 inches (152 mm) above the finished grade ground level. Chases through which the condensate and refrigerant lines run shall not terminate in the air return plenum or duct. If a portion of the condensate pipe does not drop below the height of the condensate outlet, then a trap should be installed to prevent suction of outdoor air into the air handler.

C406.1.2 Freon chases. Freon chases that terminate within the house or garage shall be sealed with closed cell expanding foam material. Pipe insulation shall be removed from the freon lines at the point of the seal to provide for complete bond between the freon line and the foam.

C406.2 Air distribution systems.

C406.2.1 Sealing. All ducts and plenums that are modified or sealed in order to achieve acceptable indoor radon concentrations, shall be made airtight in accordance with Chapter 13 of the *Florida Building Code, Building*, 2004. If ductboard is used, the seal must be on the foil side of the ductboard. Mastic sealing systems designed specifically for the conditions of use shall be used in accordance with the manufacturer's recommendations to close and seal leaks in ducts or plenums. Modifications to ducts located in crawlspaces or service areas of attics shall incorporate support, cover or other protection from accidental damage.

C406.2.2 Return plenums. If acceptable indoor radon concentrations are achieved in part by construction or modification of a return plenum, it shall be constructed with materials and closures which produce a continuous air barrier for the life of the building. Construction of the return plenum shall be done such that a continuous air barrier completely separates the plenum from adjacent building structures. If duct board is the primary air barrier, then the joints shall be sealed by fabric and mastic on the foil side of the board.

CHAPTER C501
ENGINEERED SYSTEMS

C501 General. Design of radon mitigation systems must be signed by a certified radon mitigation specialist. Additionally, for radon mitigation systems that rely upon ventilation or pressurization of the conditioned space for radon control, the plans and specifications for the ventilation or pressurization system shall be signed and where appropriate sealed according to the provisions of §471.003, *Florida Statutes* and §553.79, *Florida Statutes*. Such systems may include, but are not limited to, one of the following:

C501.1 Air pressure control. Indoor pressure may be elevated relative to subslab levels.

C501.2 Ventilation. An indoor air exchange rate may be maintained in a sufficient quantity to satisfy Section C502.1.

C502 Design criteria.

C502.1 Compliance. Any engineered radon mitigation system in compliance with this standard must maintain an indoor radon concentration equal to or less than the "not to exceed" radon exposure standard established by the Florida Department of Health during the primary hours of occupancy. The interior surfaces of buildings pressurized as the primary means of radon control, must be sealed to Section 606, Air Infiltration, and Chapter 13, Energy Efficiency Code for Building Construction, of the *Florida Building Code, Building*. The design values for total ventilation and air exchange rates for each space occupancy shall not exceed the minimums provided for each space occupancy classification in Chapter 4, Ventilation, of the *Florida Building Code, Mechanical* or the ASHRAE 62 Alternative. When these air quantities are not sufficient to maintain indoor concentrations below the acceptable level, other mitigation options shall be used.

C502.2 Tests. The indoor radon concentration must be measured in accordance with Chapter 3 and certified as acceptable according to current Florida Department of Health's rules.

C502.3 System monitoring device. Any engineered system must have a mechanism installed to automatically indicate failure of the system to building occupants, which shall be either a visual device conveniently visible to building occupants, or a device that produces a minimum 60 db audible signal.

CHAPTER C601
SOIL DEPRESSURIZATION SYSTEMS

C601 General. This chapter provides minimum design and construction criteria for active soil depressurization systems. The operating soil depressurization system shall maintain under the building a pressure less than the indoor air pressure. Systems for buildings with slab on grade floors shall as a minimum comply with Section C603.1. Systems for buildings with off grade floors shall as minimum comply with Sections C603.2 or C604.

C602 Soil depressurization system installation criteria.

C602.1 Suction fans.

C602.1.1 Fan. Suction shall be provided by a fan, rated for continuous operation and having thermal overload with automatic reset features.

C602.1.2 Seal. The suction fan shall be designed and manufactured to provide an air-tight seal between the inlet and outlet ducts and the fan housing. The fan housing must remain air-tight at air pressure equal to the rated maximum operating pressure.

C602.1.3 Rating. The rating specific to system type shall apply (see Sections C603.1 and C603.2).

C602.1.4 Location. The suction fan shall be located where any leakage of air from the exhaust portion of the fan or vent system shall be into outside air. No pressurized portion of the vent system shall pass through conditioned space.

C602.1.5 Power supply. Electrical power shall be supplied to the fan in compliance with the provisions of the *National Electric Code* and any additional local regulations.

C602.2 System monitoring device. The soil depressurization system shall include a system monitoring device which shall be either a visual device, conveniently visible to building occupants, or a device that produces a minimum 60 db audible signal, activated by the loss of pressure or flow in the vent pipe.

C602.3 Vents.

C602.3.1 Material. Piping material shall be of any type approved by locally adopted codes for plumbing vents.

C602.3.2 Slope. The vent piping shall have a minimum slope of $^1/_8$ inch (3 mm) per foot in order to drain any condensation back to soil beneath the soil gas retarder. The system shall be designed and installed so that no portion will allow the excess accumulation of condensation.

C602.3.3 Terminals. Vent pipes shall be terminated in locations that will minimize human exposure to their exhaust air. Locations shall be above the eave of the roof. To prevent reentrainment of radon, the point of discharge from vents of fan-powered soil depressurization shall meet all of the following requirements: (1) be 10 feet (3048 mm) or more above ground level, (2) be 10 feet (3048 mm) or more from any window, door, or other opening (e.g., operable skylight, or air intake) into conditioned spaces of the structure, and (3) be 10 feet (3048 mm) or more from any opening into an adjacent building. The total required distance [10 feet (3048 mm)] from the point of discharge to openings in the structure shall be measured either directly between the two points or be the sum of measurements made around intervening obstacles. If the point of discharge is at or below any window, door, or other opening into conditioned spaces of the structure the total required distance [10 feet (3048 mm)] shall be measured horizontally between the two points.

C602.3.4 Labeling. All exposed components of the soil depressurization system shall be labeled "SOIL GAS SYSTEM" to prevent accidental damage or misuse. Labels shall be on a yellow band, two inches wide and spaced three feet apart on all components.

C602.3.5 Clearance. All vent piping shall be located in compliance with existing and applicable codes, with regards to clearances from mechanical equipment and flues and notching of structural members. No vent shall penetrate a fire wall or party wall.

C603 Soil depressurization system design criteria.

C603.1 Subslab depressurization systems. Depressurization systems in sands or other granular soils shall as a minimum and within the practical limits posed by the building, meet the following requirements:

C603.1.1 Arrangement. Within the practical limits posed by the building, suction points shall be distributed as nearly equally as possible, and as follows:

1. A maximum of 1,300 square feet (120 m^2) per suction point, and
2. Each required suction point shall be located not less than 6 feet (1829 mm) nor more than 18 feet (5486 mm) from the perimeter; and
3. Multiple suction points shall be located within 36 feet (10 973 mm) of each other.

C603.1.2 Pipe size. Suction pipe should be of a size appropriate to the air-flows of the system, a minimum of 1.5 inches (38 mm) in diameter at the fan, and shall not be reduced between the fan outlet and the final termination point.

C603.1.3 Pits. Suction point pits excavated below the slab shall be sized to provide adequate pressure distribution beneath the slab. Dimensions of 22 inches (559 mm) in diameter and 11 inches (279 mm) deep, or excavation of 1 cubic foot (.02832m^3) of soil, shall be presumed to meet this requirement. Further the pit shall be filled with 1-inch (25 mm) size gravel.

C603.1.4 Rating. Suction fans must be capable of developing minimum flows appropriate to the system at 1-inch water column pressure. Fans producing 100 cubic foot per minute (cfm) (47 L/s) at 1-inch (.2488 kPa) water column pressure are presumed to meet this requirement.

C603.2 Submembrane depressurization systems.

C603.2.1 General. Submembrane soil depressurization systems are essentially the same as subslab depressurization systems, but without the cover of a concrete slab. The membrane shall be protected from wind uplift in accordance with locally adopted codes. Systems may be of suction pit or continuous ventilation mat design.

C603.2.2 Membrane soilgas retarder. A membrane soil-gas retarder shall consist of a 8 mil or thicker single ply polyethylene sheet or other sheeting material of equal or lower permeability and equal or greater strength. Place sheeting to minimize seams and to cover all of the soil below the building floor. Retarders must provide excellent environmental stress crack resistance, impact strength and high tensile strength including additives to retard polymer oxidation and UV degradation. Where pipes, columns or other objects penetrate the soil-gas retarder, it shall be cut and sealed to the pipe, column or penetration. All seams of the membrane shall be lapped at least 12 inches (305 mm). Punctures or tears in the membrane shall be repaired with the same or compatible material.

C603.2.3 Depressurization systems in sands or granular soils with suction pit design. Submembrane soil depressurization systems covering sand or other granular soils shall meet the requirements of Section C602.1, with the suction pits filled with 1-inch (25 mm) size gravel which shall be covered by $^1/_8$-inch (3.1 mm) thick steel plate, 16 gage corrugated sheet metal, or equivalent sheets of other termite resistant structural materials, in compliance with existing and applicable codes.

C603.2.4 Depressurization systems in sands or granular soils with continuous ventilation mat(s) design. Depressurization systems in sands or other granular soils and utilizing a continuous ventilation mat shall have at least 216 square inches (.14 m^2) of suction area per lineal foot and shall meet the following requirements:

603.2.4.1 Arrangement. Suction points shall be equally distributed as follows:

1. The suction point should be centrally located along the length of each unconnected strip of mat; and
2. Mat strips should be oriented along the central axis of the longest dimension of the crawlspace; and
3. A minimum of one strip shall be used for crawlspaces having widths up to 50 feet (15 240 mm) [Additional strips should be added for each additional crawlspace width of up to 50 feet (15 240 mm) width.]; and
4. The mat strip shall extend to not closer than 6 feet (1829 mm) of the inner stemwall at both ends of the building; and
5. A separate suction point and fan shall be installed for each 100 feet (30 480 mm) linear length of ventilation mat.

C603.2.4.2 Pipe size. Suction pipe shall be a minimum 3-inch (78 mm) diameter and shall be carried full size to the final termination point.

C603.2.4.3 Rating. Suction fans must be capable of developing minimum flows of at least 100 cfm (47 L/s) at 1-inch (.2488 kPa) water column pressure.

C604 Crawl space ventilation.

C604.1 Active ventilation of the crawlspace. Structures that rely upon active (fan-driven) ventilation of the crawl pace for radon control, shall utilize fans rated for continuous operation, and shall be equipped with a fan failure warning device as specified in Section 603.2, and shall have a thermal overload with automatic reset feature.

C604.1.1 Vents. Vents connecting the crawlspace with outside air shall be sized and located as required to provide mitigation of the indoor radon concentration as demonstrated by post-mitigation test, and shall not be equipped with operable louvers or other means for adjustment by building occupants. Where adjustable vents are used, they shall be permanently fixed in the proper adjustment by the mitigation contractor.

C604.1.2 Plumbing. Plumbing located in the crawlspace shall be adequately protected from freezing by insulation or means other than restriction of ventilation air.

APPENDIX D

FIRE DISTRICTS

RESERVED

APPENDIX E
Chapter 9 B-67 FLORIDA STANDARD FOR RADON-RESISTANT NEW COMMERCIAL CONSTRUCTION

9B-67.001 Purpose and intent.

9B-67.002 Definitions.

9B-67.003 Department activities.

9B-67.004 Florida Standard for Radon-Resistant New Commercial Building Construction, Adopted.

9B-67.001 Purpose and intent.

1. The provisions of this rule chapter are adopted to implement the Florida *Standard for Radon-Resistant New Commercial Building Construction* as mandated in Part X, Chapter 553, *Florida Statutes*, and are intended to provide standards for construction of radon-resistant commercial type new buildings, and to provide for the public safety, health and general welfare.
2. These rules and regulations prescribe standards for radon-resistant construction in commercial type new buildings in Florida, as may be adopted uniformly within counties by county and municipal ordinances. However, none of these provisions contained herein, or in the standards adopted, shall preclude or prohibit the owners of such buildings from exceeding these standards at their discretion.

Specific 553.98(2) FS, 1995 Supplement.
Law Implemented 553.98 FS.
History–New 2-27-96.

9B-67.002 Definitions.

For the purpose of this rule chapter, the following words, unless the text does not permit such meaning, shall have the meanings indicated:

1. Department–The Department of Community Affairs.
2. Exempted buildings–All buildings described in Items a through e are exempted from compliance with this standard. Buildings described in Item f are exempted from compliance with Sections 306 and 307 and Chapter 4 of the Florida *Standard for Radon-Resistant New Commercial Building Construction*. Elevated buildings that comply with all provisions of Item g are exempted from compliance with other portions of the Florida *Standard for Radon-Resistant New Commercial Building Construction*.
   a. Temporary structures.
   b. Free-standing greenhouses used exclusively for the cultivation of live plants.
   c. Open-air reviewing stands, grandstands and bleachers.
   d. Farm structures used only for storage or to shelter animals.
   e. Residential buildings defined as one- or two-family detached houses or townhouse apartments with no more than three stories.
   f. Buildings of occupancy classification S, Storage, or H, Hazardous (standard building code designations).
   g. Elevated buildings that satisfy all the following conditions: the structure separated from the ground by a vertical separation, measured between the final grade and the lower surface of the floor, of at least 6 feet (1829 mm); all contact between the structure and the soil consists of solid pilings, posts, piers or other supports with a total ground contact area of less than 5 percent of the horizontal projected area of the structure; all pilings, posts, piers or other supports are solid or sealed at the surface of the soil; enclosures that connect from the soil or a crawl space to the remainder of the structure comply with passive structural controls of the Florida *Standard for Radon-Resistant New Commercial Building Construction*; and the perimeter of the structure, from the ground plane to the lower surface of the lowest floor is totally open for ventilation.
3. Radon–A naturally occurring, chemically inert, radioactive gas. It is a part of the Uranium-238 decay series. Radon applies to Radon-222, and is a direct decay product of Radium-226.
4. Standard–The *Florida Standard for Radon-Resistant New Commercial Building Construction*.

Specific 553.98(2) FS, 1995 Supplement.
Law Implemented 553.98 FS.
History–New 2-27-96.

9B-67.003 Department activities.

1. The department shall provide incidental support to county and local governments implementing the Florida *Standard for Radon-Resistant New Commercial Building Construction*, to include:
   a. Interpret and clarify various aspects of the standard.
   b. Assist and provide technical support for analysis of proposed alternatives and innovations in construction to comply with this standard.
   c. Provide training on the use of the standard to building department personnel, builders, designers, and other interested persons or groups.
2. The department shall provide incidental support to persons and groups in the implementation of the Florida *Standard for Radon-Resistant New Commercial Building Construction,* to include:
   a. Support requests for information or interpretations regarding the application and administration of stan-

dards adopted herein; oral requests must be confirmed by the party in writing to the department.

b. Maintain design guidance computer model for use by building designers.

Specific 553.98(1) FS, 1995 Supplement.
Law Implemented 553.98 FS.
History–New 2-27-96.

9B-67.004 Florida Standard for Radon-Resistant New Commercial Building Construction, adopted.

1. The Florida *Standard for Radon-Resistant New Commercial Building Construction* is herein incorporated by reference. The Department shall maintain the Florida *Standard for Radon-Resistant New Commercial Building Construction*.
2. A copy of the above referenced standard has been filed with these regulations with the Secretary of State. The standard is also available for reference and inspection at the department offices in Tallahassee, Division of Housing and Community Development.

Specific 553.98(1) FS, 1995 Supplement.
Law Implemented 553.98 FS.
History–New 2-27-96.

TABLE OF CONTENTS

CHAPTER E101
GENERAL

E101 General. The design and construction requirements set forth in the following chapters and sections shall constitute and be known as the Florida *Standard For Radon-Resistant Commercial Building Construction*, hereinafter referred to as "this standard."

E102 Intent. This standard was developed in accordance with Section 553.98, *Florida Statutes*, to minimize radon entry into newly constructed commercial buildings, in compliance with the state health standard. The design, construction, and operation of buildings are governed by a variety of codes, standards, guidelines, and regulations. Nothing in this standard is intended to create a conflict with existing health and life-safety regulations.

E103 Scope.

E103.1 Applicability. The provisions of this standard shall apply to the design and construction of new commercial buildings and additions to existing commercial buildings, except single family and multiple-family residential buildings of three or fewer stories above grade and those identified in Section E104.3. When adopted by county and local government, this standard shall be applied uniformly countywide. This standard shall not be modified by a local government or building-regulatory agency.

E103.2 Additions. When the cost of an addition to an existing building exceeds 50 percent of the current value of the building; only the addition must be brought into compliance with all applicable portions of this standard, as defined in Section E104.

E104 Compliance.

E104.1 General. Buildings designed and constructed in accordance with all the applicable provisions of this standard are deemed to comply.

E104.2 New buildings and additions. All new commercial buildings and additions to existing buildings shall meet the following compliance requirements of this standard:

1. Compliance with existing local building codes and Chapter 13 of *Florida Building Code, Building*.
2. Use of methods described in Chapters 3 and 4 of this standard.

E104.3 Exemptions. All buildings described below in Items 1 through 5 are exempted from compliance with this standard. Buildings described in Item 6 are exempted from compliance with Sections E306 and E307, and Chapter 4 of this standard. Elevated buildings that comply with all provisions of Item 7 are exempted from compliance with other portions of this standard.

1. Temporary structures.
2. Free-standing greenhouses used exclusively for the cultivation of live plants.
3. Open-air reviewing stands, grandstands and bleachers.
4. Farm structures used only for storage or to shelter animals.
5. Residential buildings defined as one- or two-family detached houses or townhouse apartments with no more than three stories.
6. Buildings of occupancy classification S, storage, or H, hazardous (standard building code designations).
7. Elevated buildings that satisfy all the following conditions:
    a. The structure shall be separated from the ground by a vertical separation, measured between the final grade and the lower surface of the floor, of at least 18 inches (457 mm), and
    b. All pilings, posts, piers or other supports shall be solid, or if hollow, shall be capped by a solid masonry unit or sealed at the surface of the soil with a construction complying with all applicable portions of Chapter 3 of this standard, and
    c. Enclosures of any kind, including but not limited to chases, storage rooms, elevator shafts and stairwells, that connect between the soil and the structure, shall comply with all applicable provisions of Chapter 3 and shall have a soil contact area of less than five percent (5 percent) of the projected building floor area, and
    d. The perimeter of the structure, from the ground plane to the lower surface of the lowest floor shall be totally open for ventilation.

E104.4 Required documentation. In order to comply with this standard, all structures must include in the construction documents provided for permitting, a summary of the radon-resistant design strategies being implemented in the structure. Additionally, the building owner shall be provided with a manual substantiating the radon resistance features. This manual shall include: a summary of the radon-resistant design strategies incorporated into the structure, a listing of the design specifications for all relevant motor-driven systems; a maintenance schedule for maintaining design specifications, including active soil depressurization and heating, ventilating, and air conditioning systems; and a listing of all critical adjustments, such as intake-air damper settings.

CHAPTER E201
DEFINITIONS

E201 General. For the purpose of this Standard, certain abbreviations, terms, phrases, words and their derivatives shall be construed as set forth in this chapter. Words not defined herein shall have the meanings stated in the *Florida Building Code, Building; Florida Building Code, Mechanical;Florida Building Code, Plumbing; Florida Building Code, Fuel Gas; and Florida Fire Prevention Code*. Words not defined in these codes shall have the meanings in *Webster's Ninth New Collegiate Dictionary,* as revised. When cited throughout this standard, ASTM and ACI standards refer to the latest editions.

E202 Definitions.

ACTIVE SOIL-DEPRESSURIZATION. The lowering of air-pressure in the soil, relative to the atmospheric pressure immediately above ground level.

ACTIVE SOIL-DEPRESSURIZATION SYSTEM. A system designed to lower the air-pressure in the soil beneath a building, relative to the atmospheric pressure immediately above ground level, by continuously withdrawing air from below a membrane covering the soil. An active soil-depressurization system consists of a pressure distribution manifold, one or more radon vents, an operating fan, and a fan-failure indicator.

ADDITION. An extension or increase in floor area that can be occupied or that exchange air with the conditioned space of the building.

AND/OR. When referring to a choice of two or more provisions of this standard, signifies that use of any one provision is acceptable, and that two or more provisions may also be used together.

APPROVED. Accepted by the building official or other authority having jurisdiction.

AREA. The maximum horizontally projected area of a building or space, measured to the outside surface of the enclosing walls.

AUTOMATIC. Self-acting, providing an emergency function without human intervention, and activated as a result of a predetermined event such as an interruption of air-flow, a change in air-pressure, or the loss of electrical supply.

BACKER ROD. See "Backup."

BACKUP. A compressible material used in the bottom of sealant reservoirs to reduce the depth of the sealant, thus improving its shape factor. Backup also serves to support the sealant against sag or indentation while curing.

BLEACHERS. Tiered or stepped seating facilities without backrests in which an area of 3 square feet (.28 m^2) or less is assigned per person.

BUILDING. Any structure that encloses a space used for sheltering any occupancy. Each portion of a building separated from other portions by a fire wall shall be considered as a separate building.

BUILDING OFFICIAL. The officer or other designated authority, or their duly authorized representative, charged with the administration and enforcement of building codes.

BUTT JOINT. A nonbonded plain, square joint a keyed joint or a doweled joint between two members, where primarily movement is at right angles to the plane of the joint. Sealant in a butt joint will generally be in tension or compression, but not shear.

CAVITY WALL. A wall built of any combination of materials, so arranged as to provide a vertical air space within the wall.

COMMERCIAL BUILDING. A structure or building classified according to use by the standard building code as occupancy groups: A - Assembly, B - Business, E - Educational, F - Factory Industrial, I - Institutional, M - Mercantile, and R-Residential (except those already covered by the Florida *Standard for Passive Radon-Resistant New Residential Building Construction*).

CONTRACTION JOINT. A formed or sawed groove in a concrete structure, extending normal to the surface and to a depth of at least one-fourth the thickness of a concrete element, for the purpose of creating a weakened plane that induces a crack as internal stresses develop due to drying shrinkage.

CONSTRUCTION JOINT. The surface where two successive placements of concrete meet and are to be bonded; reinforcement is not interrupted and tie bars are used as required.

CONTROL JOINT. See "Contraction joint."

CRAWL SPACE. The unconditioned space between the bottom surface of the lowest floor of a structure and the earth, that is created when the lowest floor of the structure spans between structural supports rather than being directly supported by the earth beneath the floor.

CURING. For concrete, the maintenance of a satisfactory moisture content and temperature during its early stages so that desired properties may develop. For sealants, the maintenance of a satisfactory moisture content and temperature while the physical properties of the sealant are changed by chemical reaction.

CURING COMPOUND. A liquid that can be applied as a coating to the surface of newly placed concrete to retard the loss of water, or in the case of pigmented compounds, also to reflect heat so as to provide an opportunity for the concrete to develop its properties in a favorable temperature and moisture environment.

DETERIORATION. The physical manifestation of failure of a material or assembly (e.g. cracking, delamination, flaking, pitting, scaling) caused by environmental or internal autogenous influences during testing or service.

DIFFUSION. The movement of radon from areas of high concentration to areas of low concentration.

ELASTOMERIC SEALANT. A sealant whose macromolecular material returns rapidly to approximately its initial dimensions and shape after substantial deformation by a weak stress and release of the stress.

EMANATION. The gaseous elements produced by and given off from the radioactive disintegration of radium.

EQUILIBRIUM. The condition where the rate of decay of a radioactive parent isotope is exactly matched by the rate of decay of every intermediate daughter isotope.

EXISTING. As applied to a building or structure, one which was erected or permitted prior to the adoption of this standard.

FIELD-MOLDED SEALANT. A liquid or semisolid material molded into the desired shape in the joint into which it is installed.

FOOTING. That portion of the foundation of a structure which spreads and transmits load directly to the piles, or to the soil or supporting grillage.

FOUNDATION WALL. A wall below the first floor extending below the adjacent ground level and serving as a structural support for a wall, pier, column or other structural element.

GASKET. A deformable material clamped between essentially stationary faces to prevent the passage of air through an opening or joint.

GRADE. The top surface of the ground adjoining the exterior of a building.

GRADE BEAM. A reinforced concrete beam, usually at ground level, to form a foundation for the walls of a superstructure.

GRANDSTANDS. Tiered or stepped seating facilities where an area of more than 3 square feet (.28 m^2) is provided for each person.

GRANULAR SOIL. A soil with an air permeability greater than or equal to 10^{-12} m^2.

GROUT. A mixture of cementitious material and water, with or without aggregate, proportioned to produce a pourable consistency without segregation of the constituents.

HIGH-RANGE WATER REDUCER. A chemical admixture capable of reducing the water content of concrete at least 12 percent. This admixture shall conform to ASTM C 494 Type F and/or Type 0.

HOLLOW MASONRY WALL. A wall built of masonry units so arranged as to provide an air space within the wall.

HONEYCOMB. Voids left in concrete due to failure of the mortar to effectively fill the spaces among course aggregate particles.

ISOLATION JOINT. A nonbonded separation between adjoining parts of a structure, usually in a vertical plane, designed to allow relative movement in three directions in order to accommodate differential horizontal or vertical movement without the development of cracks elsewhere in the structure. May be either a butt joint or a lap joint, used to structurally separate the floor slab from other building elements.

KEYED. Fastened or fixed in position in a notch or other recess.

KEYWAY. A recess or groove in one lift or placement of concrete which is filled with concrete of the next placement, providing improved shear resistance at the joint.

LAITANCE. A layer of weak and nondurable material containing cement and fines from aggregates, brought by bleeding water to the outer surface of concrete.

LAP. The length by which one material overlays another at a lap joint.

LAP JOINT. A nonbonded joint in which the materials being joined override each other so that any movement of the materials is primarily parallel to the plane of the joint, putting sealants in shear rather than tension or compression. Formed slab joints that are not attached with a keyway are considered to be lap joints.

MANUFACTURED SANDS. Sands resulting from the crushing of rock, gravel or slag.

MASONRY. Construction composed of shaped or molded units, usually small enough to be handled by one person and composed of stone, ceramic brick or tile, concrete, glass, adobe, or the like.

MASTIC. A sealant with putty-like properties.

MEMBRANE. A flexible, continuous sheet. See also: “Membrane-forming,” “wring compound,” “Soil-gas-retarder membrane;” “Waterproofing membrane.”

MEMBRANE-FORMING CURING COMPOUND. A liquid material that, when applied over the surface of freshly placed concrete, forms a solid, impervious layer which holds the mixing water in the concrete.

MIDRANGE WATER REDUCER. A chemical admixture capable of reducing the water content of concrete from 6 to 15 percent. This admixture shall conform to ASTM C 494 Type A and/or Type F.

NATURAL SANDS. Sands resulting from the natural disintegration and abrasion of rock.

NET-FREE AREA. When referring to foundation vents, the area determined by multiplying the overall width and height of the object and subtracting the total area obstructed by any solid object, such as screen, mesh, louvers, and frame of the vent.

OPEN AIR. When referring to reviewing stands, grandstands and bleachers, indicates a seating facility in which the side toward which the audience faces is without an enclosing wall.

PICOCURIES PER GRAM. pCi/g, a measure of radioactivity corresponding to 0.037 radioactive disintegrations per second per gram of dry weight of a sample.

PICOCURIES PER LITER. pCi/L, a measure of radioactivity corresponding to 0.037 radioactive disintegrations per second per liter of volume.

PLASTICIZER. See “Midrange water-reducer.”

POLYETHYLENE. A thermoplastic high-molecular-weight organic compound often used in sheet form as a water-vapor retarder.

POLYURETHANE SEALANT. A building sealant consisting primarily of a polyurethane compound.

POLYVINYL CHLORIDE. A synthetic resin used in the manufacture of pipes and nonmetallic waterstops.

PREFORMED SEALANT. A sealant functionally preshaped by the manufacturer so that only a minimum of field fabrication is required prior to installation.

PRESSURE SENSITIVE. Capable of adhering to a surface without the application of additional adhesives, when pressed against it.

PSI. Pounds force per square inch.

RADIUM (Ra). A naturally occurring radioactive element resulting from the decay of uranium. For the purposes of this standard, radium applies to Radium-226. It is the parent of radon gas.

RADON. A naturally occurring, chemically inert, radioactive gas. It is part of the Uranium-238 decay series. For the purposes of this standard radon applies to Radon-222; thus, it is the direct decay product of Radium-226.

RADON POTENTIAL. A measure of the potential of soils at a building site for contributing to indoor radon concentrations.

SEALANT. Any material used to seal joints or openings against passage of solids, liquids, or gases.

SHAFT. A vertical opening extending through one or more stories of a building, for utilities, an elevator, dumbwaiter, light, ventilation, plumbing or electrical installation or a similar purpose.

SHAPE FACTOR. The relationship between the depth and width of a field-molded sealant.

SOIL-GAS-RETARDER MEMBRANE. A durable, flexible and non-deteriorating material, installed in a continuous sheet to retard the pressure-driven flow of soil gas through elements of a structure.

SOLID REINFORCED MASONRY. Masonry construction in which mortar, grout or concrete completely fills all joints and voids and in which steel reinforcement is embedded in such a manner that the materials act together in resisting forces.

STORY. That portion of a building between the upper surface of a floor and the upper surface of the floor or roof next above.

STRUCTURE. That which is built or constructed. A structure may contain one or more buildings separated by fire-rated construction elements in accordance with prevailing building codes.

SUBGRADE. The soil prepared and compacted to support a structure.

SUPERPLASTICIZER. See "High-range water reducer."

SUPERSTRUCTURE. All of that part of a structure that is above grade.

TEMPORARY STRUCTURE. A structure which is erected, occupied, and disassembled or otherwise removed from the site within a total time period of 90 calendar days or less.

WATERPROOFING MEMBRANE. A liquid sealing compound (e.g., bituminous and paraffinic emulsions, coal tar cut-backs, etc.) or nonliquid protective coatings (e.g., sheet plastics, etc.) used separately or together in a manner which renders the structural surface to which they are applied essentially impervious to water in either the liquid or vapor state.

WATER-REDUCING ADMIXTURE. A chemical additive to concrete conforming to ASTM C 94 capable of producing a reduction in mixing water or increase in flowability without causing undue set retardation or entrainment of air in the mortar or concrete.

WATERSTOP. A diaphragm used across a joint as a sealant, usually manufactured specifically to prevent the passage of water through joints in concrete structures.

WORKING LEVEL (WL). A measure of radioactive exposure equal to the total quantity of radon decay products in one liter of air that will result in the ultimate emission of 1.3 x 105 MeV (million electron volts) of energy from alpha particles. In perfect equilibrium, 1 WL equals 100 pCi/L (picoCuries per liter). It is often assumed that the air inside buildings is not in equilibrium, and that only half the radon daughters are moving freely in the air, while half are attached to dust or building surfaces. When this condition exists, an equilibrium ratio of 0.5 is said to exist. At an equilibrium ratio of 0.5, 1 WL = 200 pCi/L. For purposes of this standard, 1 WL is defined as equal to 200 pCi/L.

ZONE. That portion of a building in which the HVAC system is controllable from a single point.

CHAPTER E301
CONSTRUCTION REQUIREMENTS FOR PASSIVE CONTROLS

E301 General. Construction to these standards will limit radon entry points through building floors, walls, and foundations and will limit mechanical depressurization of buildings, which can enhance radon entry. Structural radon barriers are primarily intended to stop the pressure-driven flow of soil-gas through unsealed cracks and openings in the foundation and/or floor and into the building. Barriers can also be effective in controlling the diffusion of radon through materials and the emanation of radon from materials. An acceptable degree of redundancy and reliability is achieved only when these components are implemented as part of an integrated system of radon-resistance as prescribed by this standard. All structures shall be isolated from the soil by an approved structural barrier as defined by the applicable portions of this standard. No crack, joint, duct, pipe, conduit, chase or other opening in the building foundation or floor shall be allowed to connect soil-gas to a conditioned space or to the interior space of an enclosed space that is either adjacent to, or connected to, a conditioned space.

E302 Soil-gas-retarder membrane.

E302.1 Membrane materials. Acceptable soil-gas-retarder membranes shall consist of a single layer of polyethylene, not less than 0.006-inch (6 mils) thick with a maximum perm rating of 0.3. Polyvinyl chloride (PVC), ethylene propylene diene ter polymer (EPDM), neoprene or other nondeteriorating, non-porous material may be used instead of polyethylene, provided the installed thickness of the alternate material has greater or equal tensile strength, resistance to water-vapor transmission, resistance to puncture, and resistance to deterioration determined in accordance with ASTM E 154. The membrane shall be placed to minimize seams and to cover all of the soil below the building floor.

E302.2 Tape. Tape used to install the soil-gas retarder shall have a minimum width of 2 inches (51 mm) and shall be pressure sensitive vinyl or other non-deteriorating pressure sensitive tape compatible with the surfaces being joined. Paper tape and/or cloth tape shall not be used for these purposes.

E302.3 Mastic. Mastic used to install the soil-gas retarder shall be compatible with the surfaces being joined, and shall be installed in accordance with the manufacturer's recommendations for the materials, surface conditions and temperatures involved. Mastic may be used to join sections of membrane to one another or to elements of the building foundation, or to seal penetrations in the membrane.

E302.4 Installation. The soil-gas retarder shall be placed under the entire soil-contact area of the floor in a manner that minimizes the required number of joints and seams. Care shall be taken to prevent damage to the membrane during the construction process. In buildings incorporating the subslab portions of an active soil-depressurization system, the soil-gas retarder serves an important second purpose: to prevent mastic, cement or other materials from blocking the pressure distribution manifolds or pits.

E302.5 Seams. Seams between portions of the soil-gas retarder shall maintain a minimum of 12 inches (305 mm) of lap when concrete is placed. This may be accomplished by securing the lapped edges of the membrane with tape or mastic or using larger unsecured overlaps prior to placing concrete.

E302.6 Slab edges and joints. The soil-gas retarder shall fully cover the soil beneath the building floor. Where the slab edge is cast against a foundation wall or grade beam, the soil-gas retarder shall contact the foundation element, and shall not extend vertically into the slab more than one half the slab thickness.

E302.7 Penetrations. At all points where pipes, conduits, reinforcing bars or other objects pass through the soil-gas-retarder membrane, the membrane shall be fitted to within $^{1}/_{2}$ inch (12.7 mm) of the penetration and sealed to the penetration. When penetrations occur within 24 inches (610 mm) of a soil-depressurization-system mat or pit, the gap between the penetrating object and the soil-gas retarder shall be taped closed. When necessary to meet this requirement a second layer of the membrane, cut so as to provide a minimum 12-inch (305 mm) lap on all sides, shall be placed over the object and shall be sealed to the soil-gas retarder with a continuous band of tape.

E302.8 Punctures, cuts and tears. All damaged portions of the soil-gas-retarder membrane within 24 inches (610 mm) of any portion of a soil-depressurization-system mat or pit shall be sealed with tape or with a patch made from the same or compatible material, cut so as to provide a minimum 12-inch (305 mm) lap from any opening, and taped continuously about its perimeter.

E302.9 Mastics. Mastic may be used to join sections of soil-gas retarder to one another or to elements of the building foundation, or to seal penetrations in the soil-gas retarder, provided that mastic is kept at least 24 inches (610 mm) from any portion of a soil-depressurization-system mat or pit. Only tape may be used to seal the soil-gas-retarder membrane within 24 inches (610 mm) of a soil-depressurization-system mat or pit.

E302.10 Repairs. Where portions of an existing slab have been removed and are about to be replaced, a soil-gas-retarder membrane shall be carefully fitted to the opening, and all openings between the membrane and the soil closed with tape or mastic. Special care must be exercised to assure that mastic does not enter any portion of a soil-depressurization system located beneath the slab.

E303 Concrete floors in contact with soil-gas.

E303.1 General. Concrete slabs supported on soil or spanning over exposed soil, that are used as floors for conditioned space or enclosed spaces adjacent to or connected to conditioned spaces, shall be constructed in accordance with the following provisions of Section E303.

E303.2 Concrete for slabs.

E303.2.1 Compressive strength. Design strength for all concrete mixes used in the construction of slab-on-grade floors shall be a minimum of 3,000 psi (21 MPa) at 28 days and shall be designed, delivered and placed in accordance with ASTM C 94.

E303.2.2 Shrinkage control. In order to limit the uncontrolled cracking of floor slabs, the concrete mix design, placing practices, and curing practices prescribed in this section shall be followed. All concrete slabs-on-grade or slabs spanning above exposed soil shall be designed, placed, finished, and cured in accordance with local governing codes and applicable portions of ACI 318, *Building Code Requirements for Reinforced Concrete*; ACI 302, *Guide for Concrete Floor and Slab Construction*; and if fiber-reinforced concrete is used, the recommendations of the ACI Committee 544, *State of the Art Report on Fiber Reinforced Concrete*. ACI 302 and 544 may not be incorporated by reference for design.

E303.2.3 Mix design. Mix design for all concrete used in the construction of slab on grade floors shall specify a maximum design slump not to exceed 4 inches (102 mm). On-site slumps shall not exceed 5 inches (127 mm), provided that the total water added to the mix, including plant, transit, and site added water does not exceed the total following parameters:

1. For mixes using only natural sands, water content shall not exceed 275 pounds per cubic yard of concrete.
2. For mixes using manufactured sands, water content shall not exceed 292 pounds per cubic yard of concrete.

E303.2.4 Slump and workability. For concretes that do not contain midrange or high-range water-reducers, concrete slump measured at the point of placement in accordance with ASTM C 172, shall not exceed 5 inches (127 mm). For concretes designed and mixed containing mid-range or high-range water-reducers conforming with ASTM C 494, slump measured at the point of placement in accordance with ASTM C 172, shall not exceed 7 inches (178 mm) for mid-range and 8 inches (203 mm) for high-range water reducers.

E303.2.5 Hot weather placing and finishing. All concrete shall be placed and finished in accordance with the provisions of ACI 301, *Specifications for Structural Concrete for Buildings*. When necessary, provision for wind breaks, shading, fog spraying, sprinkling, ponding or wet covering with a light colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening and finishing operations will allow.

E303.2.6 Curing. Concrete floors shall be cured by one of the means described below and shall not be subjected to loading until the architect or engineer has determined the slab to be structurally adequate for the loads imposed.

1. Concrete floor slabs shall be cured by covering the entire slab surface for a period of seven days with clean, ponded water.
2. Concrete floor slabs shall be cured by covering the entire slab surface for a period of seven days with a continuous mist or spray of clean, potable water.
3. Concrete floor slabs shall be cured by covering the entire slab surface for a period of seven days with an impermeable sheet material conforming to ASTM C 171.
4. Concrete floor slabs shall be cured by covering the entire slab surface with a liquid membrane-forming compound that conforms with ASTM C 309. Curing compounds shall be compatible with materials specified in Section E303.3.1.

E303.3 Sealing of construction joints, penetrations, cracks, and other connections.

E303.3.1 Sealants. Sealants shall be selected and installed in compliance with ASTM C 920, *Standard Specification for Elastomeric Joint Sealants*, and ASTM C 1193, *Standard Guide for Use of Joint Sealants*.

1. Sealant materials shall be compatible with the materials they join, including curing compounds and admixtures, and with materials that will be applied over them, including floor finishing materials.
2. Field-molded sealants shall be installed in sealant reservoirs proportioned, cleaned of laitance and prepared in accordance with the manufacturer's recommendations. For elastomeric sealants, this generally requires the installation of a bond breaker or backer rod.
3. When the installed sealant is not protected by a finished floor or other protective surface, it shall be suitable to withstand the traffic to which it will be exposed.
4. Waterstops shall be preformed from polyvinyl chloride or other noncorrosive material and shall be selected and installed in compliance with ACI 504R

E303.3.2 Joints. All joints between sections of concrete floor slabs, between the floor slab and a wall or other vertical surface, or between a section of floor and another object that passes through the slab, shall be sealed to prevent soil-gas entry in accordance with the provisions of this section. Joint design depends upon the amount and type of movement that the joint must withstand. Ideally, sealing should occur as late in the construction process as possible. No portion of any joint shall be covered or rendered inaccessible unless the seal has first been inspected and approved by the building official. All such joints shall be sealed prior to the structure being certified for occupancy.

1. Butt joints. All nonbonded butt joints shall be sealed to prevent radon entry using an elastomeric sealant or a waterstop specified above. The sealant reservoir shall be sufficiently large to prevent failure of the sealant or waterstop, but in no case shall the sealant reservoir be less than $^1/_4$ inch by $^1/_4$ inch (6.4 mm by 6.4 mm) in cross section
2. Lap joints. All nonbonded lap joints shall be sealed with either a field-molded or preformed elastomeric sealant or with a flexible waterstop as specified above. The lap joint shall be sufficiently large to prevent failure of the sealant or waterstop, but in no case shall the sealant reservoir be less than $^1/_2$ inch by $^1/_2$ inch (12.7 mm by 12.7 mm) in cross section.
3. Isolation joints. All nonbonded isolation joints shall be sealed with either a field-molded or preformed elastomeric sealant or with a flexible waterstop as specified above. Isolation joints shall be sufficiently large to prevent failure of the sealant or waterstop, but in no case shall the sealant reservoir be less than $^1/_2$ inch by $^1/_2$ inch (12.7 mm by 12.7 mm) in cross section.
4. Control or contraction joints. May be used to limit unplanned cracking of floor slabs. In locations where continued movement of the slab portions can be reasonably expected, flexible sealants must be installed in reservoirs complying with the requirements of above section on butt joints, or a flexible waterstop must be used.
5. Construction joints. All bonded construction joints shall be sealed to prevent radon entry using either a rigid or an elastomeric sealant or a waterstop as specified above. Where movement of the joint is not prevented by continuous reinforcing and tie bars, flexible sealants must be installed in reservoirs complying with the requirements of above section on lap joints, or a flexible waterstop must be used.

E303.3.3 Cracks. All cracks in concrete slabs supported on soil or spanning over exposed soil, that are used as floors for conditioned space or enclosed spaces adjacent to or connected to conditioned spaces, shall be sealed against radon entry in accordance with the provisions of this section and Section E303.3.1. Ideally, sealing should occur as late in the construction process as possible.

1. Cracks greater than $^1/_4$ inch (6.4 mm) wide; all cracks that exhibit vertical displacement; all cracks that connect weakened zones in the slab such as vertical penetrations or re-entrant corners; and, all cracks that cross changes in materials or planes in the structure, shall be sealed with a flexible field-molded elastomeric sealant installed in accordance with above section on Isolation Joints.

2. Cracks greater than $^1/_{16}$ inch (1.6 mm) in width, that do not meet any of the conditions described in Item 1 above, shall be enlarged to contain a sealant reservoir not less than $^1/_2$ inch by $^1/_4$ inch (12.7 mm by 6.4 mm) in cross-section along the entire length of the crack; and shall be sealed with a flexible, field-molded elastomeric sealant installed in accordance with above section on butt joints.
3. Cracks less than $^1/_{16}$ inch (1.6 mm) in width, that do not meet any of the conditions described in Item 1 above, may be left unsealed.

E303.3.4 Stakes, pipe penetrations and other small objects. All objects that pass through the slab shall be sealed gas tight. A sealant reservoir, appropriately dimensioned to accommodate any differential movement between the object and the concrete, shall be formed continuously around the object, and the joint shall be sealed with a field molded elastomeric sealant as prescribed for isolation joints and in accordance with the provisions of Section E303.3.1. Where pipes or other penetrations are separated from the concrete by flexible sleeves, the sleeve shall be removed to provide bonding of the sealant to the object. Where stakes are used to support plumbing, electrical conduits or other objects that will penetrate the slab, the stakes shall be solid, non-porous and resistant to decay, corrosion and rust. Special care must be taken to avoid honeycombing between multiple or ganged penetrations.

1. Large utility service openings through the slab shall be sealed gas-tight. For slab-on-grade construction, this can be accomplished by fully covering the exposed soil with a vapor-retarder membrane, covered to a minimum depth of 1 inch with an elastomeric sealant. Alternatively, the opening may be closed with an expansive concrete or hydraulic cement to within $^1/_2$ inch (12.7 mm) of the top of the slab, and the remaining $^1/_2$ inch (12.7 mm) filled with an elastomeric sealant. When the opening connects to a crawlspace, the opening shall be closed with sheet metal or other rigid impermeable materials and sealed with an elastomeric sealant compatible with the materials and conditions.
2. For openings made through existing slabs, they must be sealed to meet the appropriate provisions of this section. If the opening is partially repaired with concrete, any resulting crack shall be sealed in accordance with the Section E303.3.3.
3. Any sump located in a habitable portion of a building and connecting to the soil, either directly or through drainage piping, shall be fined with a gasketed lid. The lid shall be attached so as to provide a gas-tight seal between the sump and the access space above.

E304 Walls in contact with soil-gas.

E304.1 General. Walls separating below-grade conditioned space from the surrounding earth or from a crawlspace or other enclosed volume with an exposed earth floor, shall be isolated from the soil by an approved structural baffler as described in Section E302 of this standard. Foundation walls consisting of cavity walls, or constructed of hollow masonry products or of any material in such a way as to create an air-space within the wall, shall be capped at the floor level of the first finished floor they intersect. The cap shall be either at least 8 inches (203 mm) of solid concrete or concrete filled block, or a cap that provides airflow resistance at least equal to the adjacent floor. No crack, honeycomb, joint duct, pipe, conduit chase or other opening in the wall shall be allowed to connect soil-gas to a conditioned space or to an enclosed space adjacent to or connected to a conditioned space.

E304.2 Materials. Walls governed by the provisions of this section shall be constructed of reinforced concrete, or solid reinforced masonry construction.

E305 Buildings with crawl spaces.

E305.1 General. For the purpose of this standard, buildings with crawl spaces include all buildings with the floor supported above grade.

E305.1.1 Reinforced concrete floor systems. A reinforced concrete floor constructed over crawl spaces shall conform to all applicable provisions of Section E304.

E305.1.2 Wood-framed floor systems. Wood-framed floors spanning over soil, that are used as floors for conditioned space or enclosed spaces adjacent to or connected to conditioned spaces, shall be constructed in accordance with the provisions of this section.

E305.2 Materials. Wood-framed floors constructed over a crawl space shall be constructed of American Plywood Association (APA) certified tongue-in-groove plywood, and otherwise comply with Paragraph 4.1.2 of Appendix C to Chapter 13 of the *Florida Building Code, Building*. Oriented structural board shall not be an acceptable substitute material.

E305.3 Utility penetrations. All penetrations through the floor, including but not limited to plumbing pipes and wiring, shall be fully sealed to the floor structure with approved sealant materials as per Section E303.3.1. Large service openings through the slab, such as beneath bath tub drains, shall be sealed gastight. Where large openings are created, sheet metal or other rigid materials shall be used in conjunction with sealants to close and seal the openings.

E305.4 Vertical joints. All vertical joints between the subfloor and foundation wall or the subfloor and any vertical plane of the building which extends from the crawlspace to the top of the subfloor, shall be sealed with an approved sealant (see Section E303.3.1).

E305.5 Doors and service openings. Doors, hatches or removable closures of any kind that can create an opening in the floor-plane should be avoided, but when required, shall be gasketed and installed with a latch or other permanent fastening device.

E305.6 Other radon-entry paths. All openings which connect a crawlspace and construction cavities, such as the space between wall studs, hollow masonry or precast concrete units, or floor and ceiling planes, shall be closed and sealed with an approved sealant (see Section E303.3.1).

E305.7 Crawl space ventilation. Crawl spaces shall be passively ventilated or shall be constructed with an active soil-depressurization system in compliance with Chapter 4. No portion of an air distribution system shall pass through a crawlspace.

E305.7.1 Required ventilation. Crawl spaces shall be ventilated by openings through the perimeter wall connecting to the exterior of the foundation. Required vents shall have a combined net free area not less than 1 square inch (.000645 m^2) per 1 square foot (.0929 m^2) of crawl space, and shall conform to the following conditions:

1. Openings shall be distributed uniformly around the outside walls of the crawl space.
2. Vents shall be fitted with corrosion-and decay-resistant wire mesh or grilles with openings not less than $^1/_4$ inch (6 mm) nor more than $^1/_2$ inch (12.7 mm) in size. Vents shall not be fitted with operable louvers, dampers, or other closure mechanisms.
3. Plumbing located in a ventilated crawlspace shall be protected from freezing with insulation and/or heat tape.

E305.7.2 Prohibited uses. Crawl spaces shall not be used as an air-duct or plenum or to house any duct or fan that is part of a heating, ventilating or air-conditioning system.

E306 Space conditioning systems and ventilating.

E306.1 General. All heating, ventilating and air-conditioning systems shall be designed, installed, inspected and maintained in accordance with ANSI/ASHRAE 62-1989, *Ventilation for Acceptable Indoor Air Quality*, Chapter 13 of the *Florida Building Code, Building*, and with the provisions of this section. Construction to the provisions of this section will limit radon entry points through mechanical depressurization of buildings, which can enhance radon entry. Additionally, ventilating systems shall be designed to meet all applicable codes and the provisions of this section for use of outside air of low radon concentration.

E306.2 Condensate drains. All joints in condensate piping shall be solvent welded, soldered, or otherwise connected in a leakproof and gas-tight manner. Condensate drains shall be trapped and terminate in the building sewer or outside the building, a minimum of 6 inches (152 mm) above finished grade. If the condensate piping penetrates a floor or wall separating enclosed space from the soil or from a crawl space, the penetration shall be sealed in accordance with the applicable provisions of Chapter 3. The condensate drain piping shall not terminate in a return plenum.

E306.3 Other piping. When any piping penetrates a floor or wall separating enclosed space from the soil or from a crawl space, the penetration shall be sealed in accordance with the applicable provisions of Chapter 3. In the case of insulated piping, the insulation must be removed at the point of the seal, and required seal must be made between the pipe and the building structure. Sealant must be compatible with the materials and anticipated operating temperatures. Piping shall not terminate in a return plenum.

E306.4 Plumbing and wiring chases. Wherever piping or wiring is installed in a chase that is at any point in contact with the soil or a crawl space, the chase shall be sealed to the floor or wall where it first enters the structure, in accordance with the applicable portions of Chapter 3. Piping contained in such a chase shall be sealed to the chase at the interior plane of that floor or wall. No portion of any chase shall terminate in a return air duct or plenum. Where it is impractical or prohibited by another code to seal wiring into an electrical chase or conduit, the chase shall comply with all applicable portions of Chapter 3 or the conduit shall be entirely fabricated of gas-tight components and materials.

E307 Air distribution systems.

E307.1 Air distribution systems. Any air duct, plenum, fan enclosure, or fan that is part of a building's heating, ventilating or air-conditioning system shall be completely isolated from the soil-gas by a structural barrier complying with the provisions of Chapter 3. Heating, ventilating, and air conditioning systems supplying spaces that have floors or walls in contact with soil or soil-gas shall be designed to minimize air-pressure differences and eliminate negative pressures, that cause significant flow of soil-gas through the structural barrier and into the building. Return ducts, plenums, and air handlers shall not be located in a crawl space.

E307.2 Exhaust fans, hoods, equipment, and appliances. For each zone, the required volume of outside ventilation air shall be equal to or greater than the combined volume of air capable of being exhausted by all exhaust fans, hoods, equipment, and appliances installed in the zone. This amount may not be reduced by use factors unless devices are wired and switched in a manner that prevents their simultaneous operation.

E307.3 Combustion air ducts. Ducts that provide combustion air to fuel-burning appliances and equipment shall be completely isolated from the soil-gas by a structural barrier complying with the provisions of Chapter 3.

CHAPTER E401
ACTIVE SOIL-DEPRESSURIZATION SYSTEMS

E401 General. A soil-depressurization system maintains a lower air pressure in the soil directly beneath the building floor and foundation than exists within the building. This not only draws radon away, but also causes the direction of the airflow through any possible failure in the structural barrier to be out of the building and into the soil-depressurization system. Soil depressurization systems may be installed beneath concrete slabs supported directly on the soil, or beneath the soil-gas-retarder membrane in crawl spaces.

E401.1 Prohibited uses. Soil-depressurization systems components may not extend beneath areas that are required to be depressurized by other codes for the protection of public health, for example rooms containing general anesthesia, pathogens, or poisonous chemicals. Soil depressurization systems may be installed beneath rooms that are required to be depressurized for other reasons, such as toilets and kitchens.

E402 System components. An active soil-depressurization (ASD) system is comprised of the following components: pressure distribution system porous media or manifolds; a soil cover; one or more vents; a suction fan; and a system failure indicator.

E402.1 Pressure distribution media or manifolds. A wide variety of means can be utilized to extend the low-pressure zone across the entire area beneath the structure. Acceptable means include synthetic ventilation mats, a system of perforated pipe, and an air-permeable gravel layer. Different types of pressure distribution media may be used in the same system, provided each complies with the installation requirements of this chapter. Pressure distribution media must be installed is such a way as to assure that they are never blocked by water.

1. Ventilation mats shall have a soil contact area of at least 216 square inches (.14 m^2) per lineal foot and provide a cross-section profile of at least 9 square inches (006 m^2).
2. Perforated pipe may be used to construct pressure extension manifolds. These pipes may be installed directly under the soil cover or in gravel or a similar porous medium that provides an adequate airflow connection between the pipe and the subsoil and that protects the pipe from becoming blocked by soil.
3. Continuous gravel layers of at least 4 inches (102 mm) thick are an acceptable pressure distribution medium, provided they completely cover the area of soil to be depressurized.

E402.2 Soil cover. In slab-on-grade construction, the soil cover consists of the soil-gas-retarder membrane and the concrete slab. In crawl spaces, the concrete slab may be omitted, providing the soil-gas-retarder membrane will not be subjected to wear and damage due to required maintenance procedures. In all instances, the soil-gas-retarder membrane shall be fully sealed to the radon vents in accordance with the provisions of Section E302.

E402.3 Radon vents. Radon vents are gas-tight pipes that carry the soil-gas to an area above and away from the building. Radon vent pipes shall be of a material approved by the governing local building code for plumbing vents.

E402.4 Suction fans. Suction fans create the critical pressure difference between the subslab and indoors. Suction fans shall be designed for continuous operation. Fan performance is determined by the soil characteristics, the airflow characteristics of the pressure distribution system, and the system layout, and shall comply with the airflows and operating pressures determined by the system design, as determined using the large-building active soil-depressurization model, or with criteria below for alternate compliance method. The computer model program is available through the Department of Community Affairs, Codes and Standards, 2555 Shumard Oak Blvd. Tallahassee, Florida, 32399-2100, (850) 487-1824.

E402.5 Fan-failure indicator. Each soil-depressurization system shall have a failure indicator labeled with the words "RADON REDUCTION SYSTEM FAN FAILURE INDICATOR" mounted so as to be conveniently visible to the building occupants. The fan-failure indicator may be either a visual device consisting of a light of not less than $^1/_5$ footcandle (2 lux) at the floor level, or an alarm that produces a minimum 60 db audible signal. The indicator shall be made to operate automatically when the pressure inside any radon vent pipe fitted with an operable fan is less than 0.40-inch water column (100 pascals) lower than the air pressure inside the building.

E403 ASD system design requirements.

E403.1 General. All ASD systems must comply with a design shown by the large-building active soil-depressurization model to be capable of maintaining a 0.02-inch (5-pascal) pressure differential over 90 percent of the slab or crawlspace area.

E403.2 Ventilation mat systems. Mat systems may be designed and installed in accordance with a design shown by the large-building active soil-depressurization model to be capable of maintaining a 5-pascal pressure differential over 90 percent of the slab area or with Section 503.2.2.

E403.2.1 Installation. Radon ventilation mats shall be installed immediately prior to placing the soil-gas-retarder membrane, to reduce the chance for soil to enter and block the mat. Mats shall be arranged in a pattern that provides at least two possible flow paths from any point on the mat to a radon vent pipe. Mats shall be placed with the filter material facing the compacted soil. Where sections of mat join, a minimum 6-inch (152 mm) long section of filter material at the end of one of the mats shall be loosened and the other piece of mat inserted between the loosened filter material and the first section of mat. The mats will be pressed tightly together at this lap and mechanically attached together with hog rings or metal pins driven through the mat and into the soil. Wire ties, which will puncture or tear the soil-gas-retarder membrane, shall not be used to join the mats. When properly joined, the filter material will extend continuously across the joint and the full cross-sectional area of the mat will be preserved across the splice.

E403.2.2 Alternate compliance method. Systems installed on sand or granular soil, can demonstrate compliance by meeting the following design limits:

1. Mats shall be located at least 15 feet (4572 mm) and not more than 25 feet (7620 mm) from the outside edge of the floor.
2. Mats shall be spaced not more than 50 feet (15 240 mm) on center.
3. No portion of a building floor shall be isolated from a mat by a construction feature, such as an internal footing, grade beam, foundation wall, or

other obstacle having a depth greater than the exterior foundation walls.

4. No portion of a building floor shall be more than 35 feet (10 668 mm) from a mat.
5. Mats shall be run parallel to the longest slab dimension unless obstructed by a construction feature, and arranged in a pattern that provides at least two possible flow paths from any point on the mat to a radon vent pipe.

E403.2.3 Radon vent connection. The radon vent pipe shall join to the mat in a manner that does not restrict the full air-flow capacity of the pipe. Depending upon the thickness and effective net-free-area of the ventilation mat, this may require enlarging the diameter of the vent pipe at the connection with a suitable flange, or increasing the net-free-area of the mat by installing additional layers of mat or a layer of gravel beneath the connection point. The soil-gas-retarder membrane shall be fully sealed to the radon vents in accordance with the provisions of Section 302.

E403.3 Perforated pipe systems. Perforated pipes shall be of a material approved by the governing local building code for foundation drainage, and sized according to the air-flow estimated from the large-building active soil-depressurization model. Where perforated pipes are installed in gravel meeting ASTM D 448, numbers 4 or 5 gravel, with not more than 5 percent passing a $^3/_8$ inch (10 mm) screen.

E403.3.1 Installation. Perforated pipe pressure distribution manifolds shall be installed only after the installation of all other utilities has been completed, and immediately prior to the soil-gas-retarder membrane. Pipes shall be installed with a row of perforations located at the bottom of the pipe, in order to allow condensate to drain from the system. Pipes shall be arranged in a pattern that provides at least two possible flow paths from any point in the system to a radon vent pipe. Separate sections of pipe shall be solvent welded or mechanically fastened together.

E403.3.2 Radon vent connection. The radon vent pipe shall join to the perforated pipe with a fitting that allows for the fill air-flow capacity of the vent pipe. The soil-gas-retarder membrane shall be fully sealed to the radon vents in accordance with the provisions of Section E302.

E403.4 Continuous gravel layer systems. Gravel used as the pressure distribution medium shall be installed only after the installation of all other utilities has been completed, and immediately prior to the soil-gas-retarder membrane. Where regions of gravel are isolated from one another by interior foundation elements, separate suction points shall be provided in each region, or regions shall be interconnected with pipes run horizontally through the obstruction. The size and number of such pipes shall be sufficient to provide at least two-times the anticipated air-flow. In no case shall fewer than two pipes be used to interconnect one gravel area with another. These pipes shall be separated by a horizontal distance not less than one-half the length of the boundary between the connecting gravel areas.

E403.4.1 Radon vent connection. The radon vent pipe shall join to the gravel layer with a "T" fitting that allows for the full airflow capacity of the vent pipe from either side of the "T." The fitting shall be installed with two arms in the gravel and a single arm connected to the radon vent pipe. The soil-gas-retarder membrane shall be fully scaled to the radon vents in accordance with the provisions of Section 302.

E403.5 Radon vent pipe installation. Radon vent pipes shall be solvent welded or otherwise joined to create a gas-tight connection from the soil-suction point to the vent termination point. They shall be sloped a minimum of $^1/_8$ inch (3 mm) per foot in a manner that will drain all rain and condensate back to the soil, and shall be supported in compliance with regulations for plumbing vents.

E403.5.1 Labeling. All portions of the radon vent pipe not permanently encased in a wall or chase shall be labeled to prevent accidental misuse. Labels shall consist of a pressure sensitive 2 inch (51 mm) yellow band with the words "RADON REDUCTION SYSTEM" printed in black letters at least 1 inch (25 mm) in height. These labels shall be placed on every visible portion of the vent pipe at a spacing of not more than 3 feet (914 mm). The labels shall be placed so as to be visible from any direction.

The size of vent pipes shall be determined by application of appropriate engineering principles, based on air-flow rates predicted with the large-building active soil-depressurization model. For systems that comply with the alternate compliance method, Section E403.2.2, and are installed in buildings with straight runs of vent pipes no more than 50 feet (15 240 mm) in height the required number and size of vent pipes may be determined as follows:

1. For up to 100 linear feet (30 480 mm) of ventilation mat use one 2-inch (51 mm) diameter pipe.
2. For up to 200 linear feet (60 960 mm) of ventilation mat use one 3-inch (76 mm) diameter pipe, or two 2-inch (76 mm) diameter pipes.
3. For up to 400 linear feet (121 920 mm) of ventilation mat use one 4-inch (102 mm) diameter pipe, or two 3-inch (76 mm) diameter pipes, or four 2-inch (30 480 mm) diameter pipes.

E403.5.2 Terminals. Radon vent pipes shall terminate with a rain cap, installed above the roof of the structure, and shall be located in accordance with existing codes for toxic or noxious exhausts. If not specifically addressed or applicable, vent pipes shall be terminated in locations that minimize human exposure to their exhaust air, such that the location is:

1. At least 12 inches (305 mm) above the surface of the roof;
2. At least 10 feet (3048 mm) from any window, door, or other opening (e.g., operable skylight or

air intake) to conditioned spaces of the structure; and

3. Ten feet (3048 mm) from any opening into an adjacent building.

The total required distance [10 feet (3048 mm)] shall be measured either directly between the two points or be the sum of measurements made around the intervening obstacles. If the discharge point is within two feet of elevation of the opening into conditioned space, the distance [10 feet (3048 mm)] shall be the horizontal distance between the points.

E403.6 Suction fans. Soil-depressurization system fans shall be designed to maintain the following minimum air-pressure differences at the lower opening of the radon vent pipe, as compared to the air pressure of the conditioned space above:

1. For systems using ventilation mats, 0.5 inch (.52 kPa) water column.
2. For systems using perforated pipe, 0.5 inch (.52 kPa)water column.
3. For systems using continuous gravel layers, 1.0 inch (.2488 kPa) water column.

E403.6.1 Fan sizing. Soil-depressurization systems that comply with the alternative compliance method, Section E403.2.2, and sizing, Section E403.5.2, may comply by sizing the fan as follows:

1. For up to 100 lineal feet (30 480 mm) of ventilation mat the fan shall be rated for 50 cfm (24 L/s) at 1-inch (30 480 mm) water column.
2. For 100 to 200 lineal feet (30 480 mm to 60 960 mm) of ventilation mat, the fan shall be rated for at least 100 cfm (30 480 mm) at 1-inch (30 480 mm) water column.
3. For 200 to 400 lineal feet (60 960 mm to 121 920 mm) of ventilation mat, the fan shall be rated for at least 175 cfm (83 L/S) at 1-inch (.2488 kPa) water column.

APPENDIX F

RODENT PROOFING

RESERVED

APPENDIX G
FLOOD-RESISTANT CONSTRUCTION

RESERVED

APPENDIX H
SIGNS

RESERVED

APPENDIX I
PATIO COVERS

RESERVED

APPENDIX J
GRADING

RESERVED

APPENDIX K
ICC Electrical Code

RESERVED

INDEX

A

B

C

E

F

G

I

J

K

L

N

O

R

T

U

V

W

Y