



Flood Resistant Construction and the 2010 Florida Building Code¹

January 2012

Hurricanes and other storms that result in flooding have caused billions of dollars in damage across all parts of Florida. Local jurisdictions throughout the state recognize, plan for and manage development in flood hazard areas. To participate in the National Flood Insurance Program (NFIP), communities agree to regulate all development in flood hazard areas mapped by the Federal Emergency Management Agency (FEMA).

Once an owner or developer makes a decision to construct, add to or substantially improve a building in a flood hazard area, certain requirements intended to minimize future flood damage must be satisfied. Prior to the 2010 *Florida Building Code* (FBC), those requirements were found only in local floodplain management regulations.

Flood provisions are now in the codes, making it easier for design professionals and builders to address the requirements along with other applicable load and design requirements. For additional background please reference the *Frequently Asked Questions* developed by the Florida Division of Emergency Management (DEM).

The flood provisions of the 2010 FBC achieve two broad objectives:

1. As with the rest of the code, they help fulfill the purpose of safeguarding public health, safety, and general welfare. Many Florida communities and property owners can attest that designing and constructing buildings to account for flood loads and conditions significantly reduce damage. FEMA reports that structures built

New in 2010. The FBC is accessible online through the Commission's webpage, listed under Resources.

Download excerpts of the 2010 FBC flood provisions at DEM's webpage, listed under Resources.

to NFIP criteria experience 80% less damage through reduced frequency and severity of losses. Buildings that sustain less damage are more quickly reoccupied, facilitating recovery.

2. They fulfill some of the requirements necessary for communities that participate in the NFIP. FEMA states the flood provisions of the International Code Series[®], which is the foundation of the FBC, are consistent with the NFIP requirements for buildings and structures. However, NFIP communities are responsible for regulating all development, including activities that are not within the scope of the codes. This is accomplished by the adoption of local floodplain management regulations. A model code-companion floodplain management ordinance designed specifically to coordinate with the 2010 FBC is available on the DEM webpage (See Resources).

Notice. The degree of flood protection afforded by the flood provisions in the FBC is considered reasonable for regulatory purposes and is based on scientific and engineering considerations. Larger floods can and will occur, and land outside of mapped flood hazard areas may experience flooding.

Florida law was amended in 2010 to allow communities to adopt local administrative amendments to implement the flood provisions of the FBC (see s. 553.73(5), F.S.). The statute also allows local technical amendments to adopt flood provisions that are more stringent than the FBC (also called "higher standards"). Under some circumstances, local amendments will not sunset. Model language for some higher standards is available on the DEM webpage (see Resources). Contact DEM for guidance on adoption of specific higher standards.

¹**DISCLAIMER** – This piece is intended to give the reader only general factual information current at the time of publication. This piece is **not** a substitute for professional advice and should not be used for guidance or decisions related to a specific design or construction project. This piece is not intended to reflect the opinion of any of the entities agencies or organizations identified in the materials and if any opinions appear are those of the individual author and should not be relied upon in any event. Applicable to 2010 Florida Building Code.

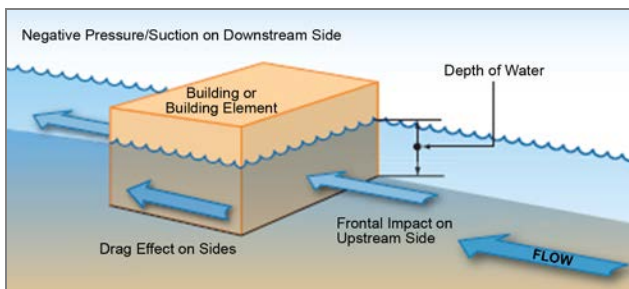
Flood Resistant Construction

The NFIP – and the FBC – requires communities to ensure that new buildings and structures in flood hazard areas are designed and constructed to resist the effects of flood hazards and flood loads. The same requirements apply to existing buildings if proposed work is determined to constitute substantial improvement or repair of substantial damage (both terms are defined in the FBC).

Chapter 16 of the *FBC, Building* requires the designer to develop flood loads, which involves determining flood conditions (flood depth, velocity, scour/erosion, and wave/debris impact). Flood loads and load combinations are described in Chapter 5 of ASCE 7, *Minimum Design Loads for Buildings and Other Structures*.

Although hydrostatic load, a function of water depth, is the most obvious load and the easiest to compute, other loads may be more important to the final design. The other flood conditions necessary to compute hydrodynamic loads are more difficult to determine (see graphic) and may require consultation with engineers who are familiar with how flood maps are prepared. The *FBC, Residential* requires a design professional to prepare designs for homes in coastal high-hazard areas, but not other flood zones. Designers and builders are cautioned to evaluate whether any flood conditions (such as velocities or waves) may warrant a closer look at flood loads.

Other aspects of flood-resistant construction found in the FBC include the use of flood damage-resistant materials and the location of electrical, plumbing, and heating, ventilation, and air-conditioning (HVAC) equipment.



Hydrodynamic loads on a building or building element.

Flood Hazard Areas and Flood Conditions

Flood Insurance Rate Maps (FIRMs) prepared by FEMA are the most common flood hazard maps adopted by Florida communities. Designers and builders should check with individual communities to determine whether a locally-prepared map is used for regulatory purposes. FIRMs identify flood hazard areas associated with the base flood (the 1%-annual-chance or “100-year” flood). Some FIRMs also identify areas subject to flooding by the less frequent 500-year flood.

FEMA labels flood hazard areas as zones:

- Zone A, AE, A1–30, AO, and AH. These zones include flood hazard areas along rivers and streams, in isolated areas where floodwaters accumulate without draining to a waterway and in coastal areas inland of Zone V and along many shorelines.
- Zone V, VE, V1–30, and VO. These zones identify coastal high-hazard areas (the *FBC, Building* calls them “flood hazard areas subject to high velocity wave action”). These zones are found along open coastlines where, during the base flood, waves are expected to be 3 feet and higher.
- Zone X (shaded) identifies areas subject to flooding by the 500-year flood and Zone X (unshaded) identifies land areas that are outside of the 100- and 500-year flood hazard areas.

Coastal A Zone. Revised FIRMs for coastal communities may have a Limit of Moderate Wave Action (LiMWA) delineated. The area between the LiMWA and the Zone V boundary or the shore is called the “coastal A zone.”

Some site-specific flood conditions can be determined using FIRMs and associated Flood Insurance Studies, while others can be estimated using the best available information (for a general discussion, see Section 5.2 in FEMA P-424, *Design Guide for Improving School Safety in Earthquakes, Floods, and High Winds*):

- Flood depth, used to compute lateral and vertical hydrostatic loads, is determined by subtracting the ground elevation from the base flood elevation (BFE) shown on the FIRM. Lateral hydrostatic loads need not be considered for enclosures below elevated buildings that have flood openings to allow floodwaters to flow in and out. Vertical (buoyant) hydrostatic loads are calculated for elements below the BFE.
- Flood velocity, used to compute hydrodynamic load, may be estimated in riverine areas if the Flood Insurance Study has a floodway data table or by using standard methods for estimating open-channel flow velocities. In coastal areas there is more uncertainty in estimating flood velocity, which is not associated with breaking waves, but is the speed of the mass movement of floodwaters. A number of FEMA references include a graph showing velocity as a function of stillwater flood depth (see FEMA P-55, *Coastal Construction Manual*).
- Debris in moving water can impart a considerable impact load when it collides with buildings. Whether debris is likely to be present, and the types and sizes of debris, cannot be determined from flood maps and studies. ASCE 7, Chapter 5 commentary, provides guidance for consideration of debris impact loads.

- Wave loads, important in coastal areas, depend largely on wave height, which, in turn, is a function of stillwater flood depth, which may be approximated using information in Flood Insurance Studies. The magnitude of wave loads can be 10 times or more higher than wind forces. ASCE 7, Chapter 5 commentary, provides guidance on determining wave loads.
- Erosion and scour may affect the stability of foundations and the loss of supporting soils should be considered because it affects flood loads. Refer to FEMA P-55 for guidance on the effects of erosion and scour.
- Duration of flooding, although not a direct contribution to flood loads, is a condition that warrants consideration. Long-duration flooding is more likely to delay reoccupancy and is a factor in whether dry floodproofing measures can be used for nonresidential buildings (not allowed in Zone V). Also, long-duration flooding is likely to cause nonstructural damage even if flood damage-resistant materials are used.

If BFEs are not shown on the flood hazard map, the FBC gives the building official the authority to require the permit applicant to obtain and use data from another source or to determine the design flood elevation (DFE) using accepted engineering practices. Many communities provide applicants with BFE or flood depth information, and some communities may allow the use of approximation methods, such as interpolating the special flood hazard area boundary based on topographic mapping.

FBC, Building – Chapter 1 Administration

The FBC administrative chapter includes flood provisions in a number of sections:

- The minimum plan review criteria include flood hazard areas, flood zones, DFE, lowest floor elevations, enclosures and flood damage-resistant materials (Sec. 107.3.5).
- As part of required inspections, submission of a certification (prepared by a Florida licensed professional surveyor) of the lowest floor elevation is required upon placement of the lowest floor and prior to further vertical construction. The final (“as-built”) certification is to be submitted as part of the final inspection (Sec. 110.3).
- The certificate of occupancy is to include a statement that the elevation certificate has been provided and is retained in the community’s records (Sec. 111.2).

See flood provisions in Sec. 102.2.5 (certain exemptions that may be adopted by enforcement districts) and Sec. 102.7 (relocation of manufactured buildings).

New in 2010. The codes use DFE, which is the same as the BFE unless the community adopts a map showing a more extensive flood hazard area with higher flood elevations.

FBC, Building

Most, but not all, flood provisions in the *FBC, Building* are found in Sec. 1612, Flood Loads (see Table 1612.1 for a listing of all flood provisions in the FBC). The following highlight the key provisions:

- Detailed specifications for flood-resistant design are not included in the code. Rather, Sec. 1612.4 refers to ASCE 24, *Flood Resistant Design and Construction*, for specific requirements. A number of requirements in ASCE 24 are based on the risk category that is assigned in Sec. 1604.5 (see Table 1604.5).
 - Elevation requirements depend on flood zone, with coastal high-hazard (Zone V) and coastal A zone requirements higher than other flood hazard areas (Zone A). See the summary in *Highlights of ASCE 24* prepared by FEMA. Elevation requirements above the BFE start at +1 foot (Risk Category II) and go up to +3 feet (Risk Category IV in Zone V).
 - The designer is to determine if “coastal A zone” conditions are present. In general, such conditions occur inland of Zone V where waves are between 3 feet and 1.5 feet high. In coastal A zone areas the design requirements are the same as Zone V (plus flood openings in walls of enclosures).
 - Specific requirements for enclosures below elevated buildings are based on flood zone. Enclosures are limited to uses for parking, storage and building access.
 - The use of dry floodproofing (only nonresidential occupancies in Zone A) is limited depending on flood velocities and adequate warning time to implement measures that require human intervention.
 - Utility equipment and machinery that serve buildings are required to be elevated or meet a specific performance expectation. Similar requirements are found in the *FBC, Mechanical*; *FBC, Plumbing*; and *FBC, Fuel Gas*.
- Sec. 1612.5 requires submission of elevation certificates (see Inspections) and, if pertinent to a specific building, certain design documentation to be prepared and sealed by a registered design professional.
- Sec. 1804.4 includes requirements for grading and fill. Where allowed in flood hazard areas, fill shall be placed, compacted, and sloped to be stable under flood conditions.

Special Requirements. Special detailed requirements (Chapter 4) based on use and occupancy include flood provisions in Sec. 419 (hospitals), Sec. 420 (nursing homes), Sec. 423 (educational facilities), and Sec. 424 (pools).

- Sec. 3109 includes requirements for buildings seaward of the Coastal Construction Control Line (CCCL). Areas seaward of the CCCL that are also mapped as flood hazard areas are subject to the more restrictive of the flood requirements and the CCCL requirements. Building officials and designers should pay close attention to the differences.
- Buildings in “high-velocity hurricane zones” (Broward and Miami-Dade counties) are required to comply with the specific provisions for those zones and also the requirements of Sec. 1612, if located in a flood hazard area (Sec. 1601.1).

CCCL and Substantial Improvements. New in 2010, the CCCL definition for substantial improvement is replaced with the definition in Sec. 1612.

FBC, Residential

Most, but not all, flood provisions in the *FBC, Residential* are found in Sec. R322, Flood-Resistant Construction (see Table 1612.1 for a listing of all flood provisions in the *FBC, Residential*). Unlike the *FBC, Building*, which refers to ASCE 24, the *FBC, Residential* includes detailed requirements. The following highlights the key provisions:

- In Table R301.2(1), communities are to identify the date of entry into the NFIP, the date of the current Flood Insurance Study, and the panel numbers and dates of currently effective FIRMs that are adopted in local floodplain management ordinances.
- Sec. R322.1 includes general provisions that apply to dwellings in all flood hazard areas (including Zone A and Zone V):
 - Dwellings proposed in identified floodways are required to be designed and constructed according to ASCE 24. This requirement recognizes that flooding is deeper and usually flows faster in floodways, which include the channel and adjacent lands that should be reserved to convey floodwaters. Obstructing flow in floodways can cause increases in flood depths, which may cause increased damage on adjacent properties.
 - In areas commonly referred to as “approximate Zone A” where FIRMs do not specify BFEs, the building official may require use of data available from another source or may require the applicant to determine flood elevations using accepted engineering practices. Keeping a record of elevations used previously is a good practice so that future permit decisions can be based on the same data.
 - Unfinished enclosures under elevated buildings are limited to uses for parking, building access or limited storage (or crawlspace). Building officials should ensure that plans specify that any enclosed areas are only for those uses. An owner who sub-

sequently modifies an enclosure in any way that alters compliance with these requirements may be subject to higher Federal flood insurance premiums.

- Utility equipment and machinery that serve buildings shall be elevated or meet a specific performance expectation that generally cannot be met by typical installations.
- Use of flood damage-resistant materials is required below the elevations required in R322.2 and R322.3. These materials are capable of withstanding direct and prolonged contact with floodwaters without sustaining significant damage. Wood products are to be pressure-preservative-treated or decay-resistant heartwood of redwood, black locust or cedars. FEMA Technical Bulletin 2, *Flood Damage-Resistant Materials Requirements*, is referenced for other materials and installation methods.
- Dwellings seaward of the CCCL that are also in mapped flood hazard areas are subject to the more restrictive of both the flood requirements and the CCCL requirements.
- Sec. R322.2 includes specific requirements that apply in flood hazard areas commonly referred to as “Zone A”:
 - Minimum elevation requirements call for the lowest floor to be at or above the DFE. However, if in a Coastal A Zone (delineated by LiMWA), the minimum elevation is the BFE +1 foot, or the DFE, whichever is higher.
 - The area below elevated dwellings may be enclosed by foundation walls or framed walls. To minimize damage due to hydrostatic loads, flood openings are required. Flood openings may be prescriptive (providing 1 square inch of net open area for each square foot of enclosed area) or engineered (requires design certification).
- Sec. R322.3 includes specific requirements that apply in coastal high-hazard areas, commonly referred to as “Zone V”:
 - Sec. R322.1.1 permits use of ASCE 24 as an alternative to the requirements of Sec. R322.3.
 - Minimum elevation requirements call for the bottom of the lowest horizontal structural member

Notice. Many Florida communities adopt a requirement that the lowest floor (or the bottom of lowest horizontal structural member) be 1 or 2 feet above the minimum elevation. This added factor of safety is called “freeboard.” Buildings that are higher than the minimum elevation sustain less damage and owners pay lower Federal flood insurance premiums.

of the lowest floor to be elevated depending on orientation of those members. If the lowest horizontal structural members are oriented such that wave crests could impact them (i.e., perpendicular to the direction of wave approach), an additional foot of elevation is required. Post-flood investigations have determined that even the occasional wave impact can lead to structural damage.

- Foundations are limited to pilings or columns because they present the least obstruction to the passage of waves. Foundation designs are required to be certified by a registered design professional.

- The area under elevated homes must be free of obstruction (see FEMA Technical Bulletin 5, *Free-of-Obstruction Requirements*). The area may be enclosed with insect screening or open lattice or, if enclosed by walls, the walls must be designed to breakaway under flood loads without causing damage to the foundation or elevated building.

Notice. Federal flood insurance is more expensive if Zone V buildings have enclosures below the BFE, even if the walls are compliant breakaway walls. And the insurance is even more expensive if enclosures are larger than 300 square feet.

FEMA Technical Bulletin 9, *Design and Construction Guidance for Breakaway Walls Below Elevated Coastal Buildings*, includes prescriptive requirements for breakaway walls. The code specifies that utility components are not permitted to be mounted on or penetrate breakaway walls because post-flood investigations have determined that walls with such components do not break away cleanly.

- Buildings in flood hazard areas in “high-velocity hurricane zones” (Broward and Miami-Dade counties) are required to comply with the specific provisions for those zones and also the requirements of Sec. R322 (also see Sec. R4401.13.1.1).
- In Zone A, above-ground pools, on-ground pools and in-ground pools that involve placement of fill are allowed without any special requirements unless located in a floodway, in which case documentation must be provided to evaluate the effects of the encroachment on flood elevations. Pools in Zone V are required to conform to the requirements of ASCE 24. For consistency, Chapter 41, Swimming Pools, cross-references to Sec. R322.
- Chapters with specifications for mechanical systems, HVAC systems, duct construction, combustion air, boilers and water heaters, special piping and storage systems, fuel gas, plumbing, plumbing fixtures, sanitary drainage and vent systems all include flood provisions. In general, the pertinent sections refer to Sec. R322.1.6.

FBC, Existing Building

A fundamental premise of the *FBC, Existing Building* is that work on an existing building does not lessen the compliance of the structure. It is important to keep this in mind when considering projects that repair, alter, add to, or otherwise improve buildings in flood hazard areas that were originally built to comply with flood-resistant requirements. For example, the open area under buildings required to be elevated on pilings is permitted to be enclosed by walls only if the walls comply with the flood-resistant construction requirements, including limiting use of the resulting enclosure only to parking, building access or storage.

The first step when considering work on an existing building in a flood hazard area is to determine whether the proposed work constitutes “substantial improvement” (SI) or repair of “substantial damage” (SD). If a proposal is determined to be SI/SD, then the existing building is required to be brought into compliance with the requirements for new construction found in Sec. 1612 of the *FBC, Building*.

Notice. Some Florida communities enforce “cumulative” SI. They keep records and evaluate whether each subsequent proposal to improve or repair a building will trigger the SI requirement to bring buildings into compliance with the requirements for new construction.

The SI/SD determination is made by comparing the cost of all of the proposed work to the market value of the building (excluding land) before the work is undertaken. If the proposal is to repair a damaged building, the market value is the value of the building before the damage occurred. When the cost equals or exceeds 50% of the market value, the work is determined to be substantial improvement or repair of substantial damage. In 2010, FEMA published FEMA P-758, *Substantial Improvement/Substantial Damage Desk Reference*, to summarize extensive guidance.

The flood provisions of the *FBC, Existing Building* are found in each chapter (see Table 1612.1 for a listing of all flood provisions in the *FBC, Existing Building*):

- Repairs. Chapter 5 has a general requirement that requires compliance when the repair of a building in a flood hazard area constitutes substantial improvement (Sec. 501.3). Sec. 506.2.4 also specifies that buildings that have sustained substantial damage shall be brought into compliance with the requirements of Sec. 1612 of the *FBC, Building* for new construction.
- Alterations – Levels 1, 2, and 3. Chapter 6, Alterations – Level 1, has a general requirement that requires compliance when alterations constitute substantial improvement (Sec. 601.3). Because the requirements for alterations are cumulative, the requirement in Chapter 6 also applies to Level 2 alterations (Chapter 7) and Level 3 alterations (Chapter 8).

- Additions. Handling additions is complicated by the fact that some circumstances prompt compliance of the addition as well as the base building. Sec. 1003.5 distinguishes between horizontal additions that are structurally connected and those that are not structurally connected. It also specifies that if vertical additions or foundation work are determined to constitute substantial improvement, then base buildings have to be brought into compliance. DEM's guidance listed in Resources is based on FEMA P-758.
- Historic Buildings. The key to proper enforcement of the flood provision is whether a historic building meets the exception in Sec. 1101.3. The *FBC, Existing Building* defines "historic buildings;" however, the definition is not entirely consistent with the definition used by the NFIP. The NFIP allows historic buildings in flood hazard areas to be improved and repaired without bringing them into compliance provided they are qualified. Importantly, any proposed work must allow such buildings to continue to be listed as historic. FEMA guidance suggests that building officials require applicants to obtain evidence of continued designation from the appropriate authority.
- Relocated or moved buildings. Sec. 1202.6 specifies that buildings relocated or moved into flood hazard areas are required to comply with the flood provisions of Sec. 1612. This means new foundations must meet the elevation and other requirements based on the flood zone of the new location.
- The sections that articulate the prescriptive compliance method for additions, alterations, and repairs each specify that if the work constitutes SI/SD, then the existing building shall be brought into compliance with the requirements for new construction (Chapter 3). Similarly, the performance compliance method includes the same requirement (Chapter 13).

FBC, Mechanical, Plumbing, Fuel Gas

Each of these codes includes similar provisions requiring equipment and systems to be located at or above the elevation specified in Sec. 1612.4 (thus matching the elevation of the building) or to meet a specific performance expectation that generally cannot be met by typical installations. See Table 1612.1 for a listing of all flood provisions in these codes. Of particular note:

- Each of the codes specifies that systems and equipment shall not be mounted on or penetrate walls intended to break away under flood loads (applies in Zone V).
- *FBC, Mechanical* requires ducts to be located above the elevation specified in Sec. 1612.4 or designed and constructed to prevent water from entering or accumulating and to resist flood loads.

Resources:

2010 *Florida Building Code*, International Code Council, Inc. Accessible online at www.FloridaBuilding.org

DEM Local Ordinance & Building Code Resources (www.floridadisaster.org/Mitigation/SFMP/lobc_resources.htm):

Frequently Asked Questions on the Flood Provisions of the 2010 Florida Building Code (October 2011)

Flood Provisions of the 2010 Florida Building Code

Guidance for Additions to Buildings in Special Flood Hazard Areas (June 2010)

ASCE 7, *Minimum Design Loads for Buildings and Other Structures* (2010)

ASCE 24, *Flood Resistant Design and Construction* (2005). See *Highlights of ASCE 24* available at www.fema.gov/rebuild/buildingscience/index.shtm

FEMA P-55, *Coastal Construction Manual* (Fourth Edition, April 2011; www.fema.gov/library/viewRecord.do?id=1671)

FEMA P-424, *Design Guide for Improving School Safety in Earthquakes, Floods, and High Winds* (December 2010; www.fema.gov/library/viewRecord.do?id=1986)

FEMA P-758, *Substantial Improvement/Substantial Damage Desk Reference* (May 2010; www.fema.gov/library/viewRecord.do?id=4160)

NFIP Technical Bulletins: A series that provide guidance on a variety of floodplain management topics (www.fema.gov/plan/prevent/floodplain/techbul.shtm)

Answers to specific questions:

Florida Division of Emergency Management, State Floodplain Program Office: 850-413-9960 or floods@em.myflorida.com

Building Codes and Standards Office/Florida Building Commission: 850-487-1824 or www.FloridaBuilding.org

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