FEDERAL EMERGENCY MANAGEMENT AGENCY

Flood Provisions of the International Code Series: Higher Standards and More Specific Requirements than the Minimum Requirements of the National Flood Insurance Program

June, 2013

Building Science Branch
FEMA Federal Insurance and Mitigation Administration
Contact: John Ingargiola, Civil Engineer, CBO, CFM
John.Ingargiola@dhs.gov

Appendices

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1 Improving Flood Resistance through Building Codes

The flood provisions of the 2012, 2009, and 2006 editions of the International Code Series (I-Codes) are consistent with the minimum requirements of the National Flood Insurance Program (NFIP) for buildings and structures.[1] The Federal Emergency Management Agency (FEMA) has worked since 1998 to incorporate flood provisions into the I-Codes. This paper summarizes the provisions of the I-Codes that are more detailed or that exceed the NFIP minimums. In addition to building codes, communities may also regulate development in flood hazard areas through such mechanisms as zoning ordinances, subdivision regulations, health regulations, and special purposes ordinances such as floodplain, grading, and erosion control ordinances.

Most states that adopt buildings codes adopt and require enforcement of codes that are based on one or more of the model codes developed by the International Code Council. Most states that do not mandate a building code allow local jurisdictions to adopt codes. The I-Codes are a family of codes that include the International Building Code® (IBC), International Residential Code® (IRC), International Existing Building Code® (IEBC), and codes for mechanical, plumbing, and fuel gas installations.

Excerpts of the flood provisions of the 2009 and 2012 I-Codes are available online at http://www.fema.gov/building-science/building-code-resources.

2 Higher Standards in the IRC and IBC

2.1 Base Flood Elevation versus Design Flood Elevation

The NFIP regulations use the base flood as the regulatory flood, and the Base Flood Elevation (BFE) as the minimum elevation level required for protection of buildings and structures. The base flood is the flood that has a one percent chance of being equaled or exceeded in any given year (commonly called the "100-year" flood). The NFIP Flood Insurance Rate Maps (FIRMs) depict Special Flood Hazard Areas (SFHAs), which are areas subject to flooding by the base flood. Many SFHAs were delineated using estimation methods that do not produce BFEs. In these areas, communities are to check if flood hazard information is available from other sources. Communities may use a number of techniques to develop BFEs, or applicants can have engineers develop BFEs.

NFIP. The NFIP regulations allow communities to adopt flood hazard maps other than the FIRMs as their regulatory flood maps, as long as the adopted maps include, at a minimum, all of the areas designated as SFHA. Some riverine communities recognize that development in upper

[1] According to Title 44 Code of Federal Regulations §§ 59.1 and 60.3 (building codes do not regulate non-building development, which NFIP-participating communities are required to regulate).

watersheds will increase runoff over time and cause more frequent flooding of greater depths than experienced in the past. Some of these communities prepare studies and maps to delineate the "future condition" flood hazard area and use it as the basis for regulation. While the flood event used for this purpose is the "future condition base flood," it is not today's base flood. Other communities use the flood of record and adopt a map that delineates the area actually flooded by that event as the basis for applying regulations.

I-Codes/ASCE 24. The I-Codes and ASCE 24, a standard developed by the American Society of Civil Engineers (ASCE) use the term Design Flood Elevation (DFE). The term DFE traces back many years, originating in ASCE 7, *Minimum Design Loads for Buildings and Other Structures,* and the first edition of ASCE 24, *Flood Resistant Design and Construction*. The DFE is the elevation of the design flood: the design flood is the greater of the base flood or the flood corresponding to the area designated on the community's flood hazard map, whichever is higher. The majority of NFIP communities adopt the FIRM as their regulatory instrument, in which case the DFE is the BFE. As described above, when a community adopts a different flood hazard map, the elevations shown on that map are the DFE.

2.2 Buildings Wholly or Partially in Flood Hazard Areas

Communities that participate in the NFIP are required to review permit applications to determine whether proposed building sites will be reasonably safe from flooding. If a proposed building site is in an SFHA, then certain requirements apply to both new construction and Substantial Improvement of existing buildings. (Refer to Section 5.1 of this paper for the definition of Substantial Improvement.)

NFIP. The regulations do not specifically address how communities are to handle situations where a building is partially in the SFHA, where a building is in more than one flood hazard zone, or where a building site is affected by more than one BFE. NFIP guidance states that when a building is in more than one zone, the requirements of the more restrictive zone apply. Thus, a building that is partly in the SFHA must comply with the requirements for the SFHA, and a building that will be in more than one flood zone must comply with the requirements for the more restrictive zone. Similarly, a building that is affected by more than one BFE must comply with the higher of the identified BFEs.

I-Codes/ASCE 24. The I-Codes and ASCE 24 explicitly apply to buildings and structures, and portions of buildings and structures, that are located, in whole or in part, in flood hazard areas. The IBC explicitly states that the provisions associated with the more restrictive flood hazard area apply (Sec. 1612.1).

2.3 Authority to Require Applicant to Determine the BFE

Many SFHAs shown on FIRMs do not designate BFEs. These SFHAs, commonly referred to as "unnumbered" or "approximate" Zone A, are delineated by FEMA using methods other than detailed engineering studies.

NFIP. If BFEs are not provided, the NFIP regulations require communities to "obtain, review, and reasonably utilize base flood elevation and floodway data available from a Federal, State, or other source." Sources generally include the U.S. Department of Agriculture's Natural Resource

Conservation Service (or local soil conservation office), the U.S. Army Corps of Engineers, local roads departments, or State highway departments. The NFIP regulations do not have a "default" height above grade that specifies how high the lowest floors must be in these approximate zones, although guidance suggests a specific height if information from other sources is not available. Many State model ordinances and ordinances adopted by many communities include a specific height above grade.

I-Codes. The IBC and IRC both clearly authorize the building official to require the applicant to obtain and reasonably utilize any DFE and floodway data available from federal, State, or other source or to determine the DFE and/or floodway in accordance with accepted engineering practices.

ASCE 24. ASCE 24 includes the technical provisions that apply to the design and construction of buildings and structures in flood hazard areas. The assumption is that the BFE/DFE is already determined before the design is started. Administrative functions of communities, such as determining the applicable BFE/DFE, are set in building codes or local regulations, not in design standards.

2.4 Inspections

NFIP. Under the NFIP communities are required to ensure that all new construction and Substantial Improvement of buildings meet or exceed the minimum floodplain management requirements of the NFIP. The most effective way to ensure compliance is to inspect the site frequently during construction. The NFIP regulations require communities to obtain and retain documentation of the elevations of new construction and Substantial Improvements.

I-Codes. The I-Codes include sections that list a series of inspections, including "lowest floor inspections" (IBC) and "floodplain inspections" (IRC) upon placement of the lowest floor and prior to further vertical construction. At that time, the permittee is to submit elevation documentation. Unlike many aspects of a building under construction that can be checked visually, elevation above a datum is not readily verified. Obtaining the elevation information at this stage in construction allows both the builder and the local official to check that the lowest floor elevation is correct. It is easier and less expensive to catch an error during construction than to discover it when the as-built elevation certificate is completed.

The 2012 I-Codes specify another inspection that requires another submission of elevation documentation prior to the final inspection. The FEMA Elevation Certificate provides more than just the surveyed elevation of the lowest floor—it documents the elevation of the lowest equipment and information about openings in the walls of enclosures. Having the Elevation Certificate in hand before the final inspection helps the local official verify compliance with flood requirements.

ASCE 24. ASCE 24 includes the technical provisions that apply to the design and construction of buildings and structures in flood hazard areas. Administrative functions of communities, such as the type and scheduling of inspections, are set in building codes or local regulations, not in design standards.

2.5 Provisions in Multiple I-Codes and Multiple Sections

Several of the codes in International Code Series (I-Codes) include flood provisions, and each has flood provisions in several sections. This is different from most local floodplain management regulations, which are typically codified in a single chapter of the community's local regulations. Flood provisions are found in multiple sections of the I-Codes to ensure that everyone who works on designing and constructing buildings in flood hazard areas will see the applicable provisions.

IRC. Because the IRC is prescriptive, it includes all specifications necessary to build dwellings, including provisions for mechanical, plumbing, and fuel gas systems. Thus, each chapter that applies to those aspects has flood provisions so that each specialty trade is aware of the requirements when working on dwellings in flood hazard areas. For example, when a homebuilder calls the plumber, the plumber will use the provisions in the IRC plumbing chapter rather than the International Plumbing Code. Flood provisions are in IRC sections that address duct construction, combustion openings, boilers and water heaters, special piping and storage systems, fuel gas, and general plumbing requirements.

IBC/ASCE 24. Under the IBC, the designer is referred to the International Mechanical Code, International Plumbing Code, and International Fuel Gas Code. Each of those codes has flood provisions. This is also important during construction because the professionals responsible for installing mechanical, plumbing, and fuel gas systems also use the requirements of those codes. ASCE 24 includes all requirements for utilities and equipment in a single chapter.

2.6 Structural Fill

Structural fill is earthen fill that is used to support buildings. To properly support a building, earthen fill must be free of organic material, construction debris, cobbles, and boulders, and it must be placed in layers and compacted to provide sufficient strength and stability to carry the weight of the building, when subject to loads, without shifting or loss of support. In flood hazard areas, especially those with long-duration flooding, saturation of fill needs to be considered because saturation alters the bearing capacity of the fill material. Also, because flow velocities may cause erosion, the side slopes of fill placed to elevate a building may need to be flatter than typically used, and vegetative ground cover or other erosion protection may need to be provided.

NFIP. The NFIP regulations for development in special flood hazard areas are silent on the use of earthen fill to elevated buildings, although the general performance expectation that building sites will be reasonably safe from flood applies. The regulations do not specify how fill should be placed or compacted. FEMA Technical Bulletin #10 *Ensuring That Structures Built on Fill In or New Special Flood Hazard Areas Are Reasonably Safe From Flooding,* explains what is required to ensure that buildings on fill are "reasonably safe from flooding."

IRC. Section R401.2 requires foundations that are capable of accommodating all loads, and fill soils that support footings and foundations to be designed, installed, and tested in accordance with accepted engineering practice. Section R506 requires fill material used to support concrete slab-on-ground floors to be free of vegetation and foreign material. Fill is to be compacted to assure uniform support of the slab and approval is required for fill depths that exceed 24 inches for clean sand or gravel or 8 inches for earth. Given those depth limitations, approval is likely

required for most fills used to elevate homes in flood hazard areas, and code officials can require builders to obtain a report or design from a qualified design professional.

IBC. IBC Chapter 18 covers soils and foundations in general. In addition to the other requirements of this chapter, Section 1804.4 addresses grading and fill in flood hazard areas and states that fill shall be placed, compacted, and sloped to minimize shifting, slumping, and erosion during the rise and fall of flood water and, if applicable, wave action. To meet the required performance objective, a qualified design professional is usually required to design the fill.

ASCE 24. ASCE 24, Section 2.4 covers use of fill. If a soils engineering report is not required by the community, then certain lift thickness and compaction specifications must be met. ASCE 24 specifies that side slopes shall be no steeper than 1 vertical to 1.5 horizontal and shall be protected from scour and erosion during flooding up to and including the design flood.

2.7 Flood Damage-Resistant Materials

NFIP. The NFIP regulations require that new construction and Substantial Improvements are constructed with materials that are resistant to flood damage, but do not define what that means. FEMA guidance on materials is in Technical Bulletin #2 *Flood Damage-Resistant Materials Requirements*. This guidance describes five classes of materials ranging from those that are highly resistant to flooding, to those that have no resistance. A lengthy table lists materials by generic names and notes whether the materials are acceptable or unacceptable for use below the BFE.

IRC. Section R322.1.8 includes specifications for wood, allowing use of woods that are preservative-treated in accordance with a specific standard, or use of "decay-resistant heartwood of redwood, black locust or cedars." This section also requires materials and installation methods used for flooring and interior and exterior walls to conform to the provisions of FEMA Technical Bulletin #2.

IBC/ASCE 24. IBC Section 1612, by reference to ASCE 24, requires flood damage-resistant materials to be used below specified minimum elevations. ASCE 24 Section 5 has specifications for metal connectors and fasteners, structural steel, concrete, masonry, wood and timber, and finishes. IBC Section 801.5 (interior finishes) calls for flood damage-resistant materials, and Section 1403 (exterior walls) specifies the same preservative treatment or decay-resistant woods that are listed in the IRC.

2.8 Flood Openings

NFIP. The NFIP specifies that fully enclosed areas below the lowest floor of elevated buildings are "designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exist of floodwaters." Two design options are identified: either the designs must be certified by a registered professional engineer or architect, or the openings are to meet or exceed minimum criteria, including that a minimum of two openings have a total net area of not less than one squire inch for every square foot of enclosed area subject to flooding.

IRC. Section R322.2.2 explicitly specifies that the minimum of two openings shall be on different sides of each enclosed area (which helps minimize the likelihood that floating debris

will block the openings and impair intended performance). In addition, the IRC provides that "openings shall be not less than 3 inches in any direction in the plane of the wall."

IBC/ASCE 24. IBC Section 1612, by reference to ASCE 24, requires a minimum of two openings on different sides of each enclosed area and specifies that the minimum dimension of openings must not be less than 3 inches in any direction in the plane of the wall. ASCE 24 uses the term "nonengineered openings" for those that provide a total net area of at least 1 square inch for each square foot of enclosed area and "engineered openings" for those that are certified by a design professional.

2.9 Walls Designed to Break Away and Equipment

NFIP. The NFIP specifies the performance for non-supporting breakaway walls, if walls are used to that may be used to enclose areas below elevated buildings. Such walls are required in Zone V, and may be allowed in Zone A. The intent is that such walls "collapse under wind and water loads without causing collapse, displacement, or other structural damage to the elevated portion of the building or supporting foundation system." Post-flood investigations have determined that walls do not breakaway as designed if electrical, mechanical, and plumbing system components and equipment are mounted on or penetrate through breakaway walls. Although the NFIP does not explicitly state that breakaway walls should be free of such elements, it is implied in the performance statement.

IRC. Section R322.3.4 explicitly requires that "electrical, mechanical, and plumbing system components are not to be mounted on or penetrate through walls that are designed to break away under flood loads."

IBC/ASCE 24. IBC Section 1612, by reference to ASCE 24, explicitly requires that "utilities and attendant equipment shall not be mounted on, pass through, or be located along breakaway walls."

2.10 Manufactured Homes

NFIP. The NFIP regulations specify that manufactured homes are to be elevated on permanent foundations that meet minimum elevation requirements based on flood zone (the lowest floor at or above the BFE in Zone A and the bottom of the lowest horizontal structural member at or above the BFE in Zone V). Homes are to be securely anchored to adequately anchored foundation systems to resist floatation, collapse, and lateral movement. The rules allow manufactured homes in existing manufactured home parks or subdivision to be elevated such that the lowest floor of the manufactured home is at or above the BFE or the manufactured home chassis is supported by reinforced piers or foundation elements that are no less than 36 inches above grade.

IRC. Many states regulate the initial installation of manufactured homes under an authority other than the building code, although many communities require permanent foundations to comply with the building code (typically the residential code). IRC Section R322.1.9 has requirements for manufactured homes, but does not include the option to allow certain units to be installed on piers or foundation elements that are only 36 inches above grade.

IBC/ASCE 24. The body of IBC and ASCE 24 do not have specific requirements for manufactured homes. IBC Appendix G requires foundations to be designed in accordance with IBC Section 1612 and the option to allow certain units to be installed on piers or foundation elements that are only 36 inches above grade is not included.

3 Higher Standards: IRC

3.1 Scope of the IRC

The scope of the IRC includes the "construction, alteration, movement, enlargement, replacement, repair, equipment, use and occupancy, location, removal and demolition of detached one- and two-family dwellings and townhouses not more than three stories above grade plane in height with a separate means of egress and their accessory structures." Where a dwelling or townhouse exceeds the allowed number of units or stories, does not provide individual egress for each dwelling unit, or does not conform to the prescriptive provisions of the code, the structures are beyond the scope of the IRC and the buildings must conform to the requirements of the IBC.

3.2 Floodway per ASCE 24

Sections R301.2.4 and R322.1 specify that buildings in floodways are required to be designed and constructed in accordance with ASCE 24. Floodways are the channels and adjacent areas of the SFHA that must be reserved to convey the base flood without increasing the water surface elevation by more than a certain amount. In general, floodwaters in floodways are deeper and faster than in the adjacent floodway fringe areas. Like the IBC and IRC, ASCE 24 specifies that structures and fill shall not be placed in floodways unless it is demonstrated that there will be no increase in flood level and no reduction in conveyance of the floodway. In terms of design, the requirement to use ASCE 24 has two important effects:

1. ASCE 24 requires the determination of flood loads and requires foundations to be designed to resist flood loads. In addition, if fill is used to elevate a building, the fill must be designed for the anticipated conditions, including saturation, scour, and erosion.

2. ASCE 24 requires residential structures (and all Category II buildings) to be elevated to the BFE + 1 ft or DFE, whichever is higher. Therefore, homes in floodways are required to be elevated at least 1 ft higher than homes in floodway fringe areas.

3.3 Alternative to Use ASCE 24 in Zone V

Sections R301.2.4.1 and R322.1.1 permit the use of ASCE 24 as an alternative to the requirements of R322.3 for dwellings in coastal high-hazard areas (Zone V). Coastal high-hazard areas are designated where wave heights higher than 3 ft are expected during the base flood. This provision allows code officials to specify use of ASCE 24 and allows designers to elect to use ASCE 24. Using ASCE 24 has three important benefits:

1. ASCE 24 requires foundation designs to explicitly take into account anticipated erosion and local scour.

2. ASCE 24 has a significant amount of detail for the design of pile foundations.

3. ASCE 24 and the IRC require residential structures in Zone V to be specifically elevated in relation to the orientation of the lowest horizontal structural member, with an additional foot of elevation required if the members are positioned such that wave crests could impact them, imparting load.

3.4 Foundation Wall Height Limitations in Zone A

The IRC is a prescriptive code, which means that unless specified, a registered design professional is not required to design dwellings. IRC Section R322.2.3 imposes some limitations on foundation wall heights, unless the walls are designed in accordance with Section R404, Foundation and Retaining Walls. The limitations apply to 6-inch and 8-inch plain masonry walls and 8-inch reinforced masonry walls. These limitations were determined by a series of computations of flood loads that considered a range of depths (4, 6, 8, and 9 feet) and a range of velocities (3, 6, and 9 feet per second). If walls higher than these height limitations specified are required, then a design professional is required to develop the foundation design.

3.5 Coastal A Zones

Coastal A Zones (CAZ) are areas within SFHAs that are inland of Zone V and inland of some shorelines without Zone V, where there is the potential for breaking waves to be higher than 1.5 ft during the base flood. Post-flood investigations and laboratory evaluations have determined that waves of 1.5 ft and higher cause considerable damage to conventional construction that does not use piling or column foundations. IRC Section R322.2 specifies that if such areas have been delineated (e.g., a Limit of Moderate Wave Action, or LiMWA, shown on the FIRM), they shall be designated as Coastal A Zones and the lowest floors of dwellings in these areas shall be elevated to or above the BFE plus 1 ft, or the DFE, whichever is higher.

3.6 Minimum Elevation Requirements

The NFIP regulations specify minimum building elevation requirements based on flood zone:

- In SFHAs designated Zone A, including Zone A areas with waves less than 3 ft high that are immediately inland of Zone V, the lowest floor shall be at or above the BFE (and the reference point is the top of the floor).

- In SFHAs designated Zone V, the bottom of the lowest horizontal structural member of the lowest floor (excluding pilings and columns) shall be at or above the BFE.

IRC Section R322.2.1 specifies elevation requirements in flood hazard areas that are not subject to high-velocity wave action (i.e., in Zone A). In all such areas, buildings shall have the lowest floors elevated to or above the DFE, except in areas designated as Coastal A Zones. In Coastal A Zone areas, the lowest floor shall be elevated to or above the BFE + 1 ft or the DFE, whichever is higher. R322.2 states that if flood hazard areas have been delineated as subject to wave heights between 1.5 ft and 3 ft, the areas shall be designated as Coastal A Zones. Flood maps prepared by FEMA after December 2009 show the inland extent of the 1.5 ft wave, the LiMWA.

IRC Section R322.3.2 specifies elevation requirements in coastal high-hazard areas (i.e., Zone V). In all such areas, the required minimum elevation is determined based on whether the lowest horizontal structural member is oriented parallel to or perpendicular to the direction of wave

approach (consistent with the manner in which elevations are specified in ASCE 24). During conditions of flooding, some waves are expected to rise higher than the BFE specified on the FIRM, in which case the impact of even the crests of those higher waves can impart considerable load on lowest horizontal structural members. If the lowest horizontal structure members are oriented to allow those waves to pass through without impacting the members, the structure does not experience the same wave loads as it would if the members are impacted. Therefore, if a home is oriented such that the lowest structural members are likely to be impacted, the IRC and ASCE 24 require higher elevation. The IRC requires:

- If the lowest horizontal structural member is oriented parallel to the direction of wave approach, the "lowest portion of all structural members supporting the lowest floor, with the exception of mat or raft foundations, piling, pile caps, columns, grade beams and bracing" shall be located at or above the DFE.

- If the lowest horizontal structural member is oriented perpendicular to the direction of wave approach, the "lowest portion of all structural members supporting the lowest floor, with the exception of mat or raft foundations, piling, pile caps, columns, grade beams and bracing" shall be located at or above the BFE plus 1 ft or the DFE, whichever is higher.

4 Higher Standards: IBC/ASCE 24

4.1 Scope of the IBC

The scope of the IBC includes the "construction, alteration, movement, enlargement, replacement, repair, equipment, use and occupancy, location, maintenance, removal and demolition of every building or structure or any appurtenances connected or attached to such buildings or structure," except detached one- and two-family dwellings and townhouses not more than three stories above grade plane in height with a separate means of egress and their accessory structures, which must meet the provisions of the IRC.

For floodplain management purposes, it is important to understand that the IBC specifies Use and Occupancy Classifications, and each building is to be classified in one or more of the Use Groups defined in the code. This is especially important because of the NFIP (and code/ASCE 24) limitations on dry floodproofing, a protection technique that is permitted only for nonresidential buildings in A Zones. Two Use Groups include buildings that are residential in nature, where people are cared for or live on a permanent or transient basis: Institutional Group I and Residential Group R.

4.2 Occupancy Categories

The structural design chapter of the IBC, Chapter 16, requires that each building and structure be assigned an "Occupancy Category," which is used to determine the structural requirements based on the nature of occupancy or how the building is intended to be used. The IBC includes a table that describes the nature of Occupancy Categories; this table is equivalent to the Structure Category classification in ASCE 7, sometimes referred to as an "importance factor." The IBC, by reference to ASCE 24, specifies elevation requirements as a function of Occupancy Category

(refer to Section 4.5 of this paper for a summary of the elevation requirements). The Occupancy Categories are listed in increasing importance:

- Category I includes agriculture facilities, temporary structures, and minor storage buildings pose little risk to people because they are not occupied;
- Category II includes most buildings because it includes all buildings that are not Category I, III, or IV;
- Category III structures represent a substantial hazard to human life in the event of failure; examples of buildings with specific occupancy loads (number of people) such as schools and healthcare facilities, and buildings such as water treatment facilities and waste water treatment facilities, that should be assigned this category; and
- Category IV structures are essential facilities, which the code defines as "buildings and other structures that are intended to remain operational in the event of extreme environmental loading from flood, wind, snow or earthquake." As with Category III, examples of buildings that should be assigned this category are provided, such as fire, rescue, ambulance and police stations.

Category III and Category IV include facilities that FEMA and emergency managers consider to be "critical facilities."

4.3 ASCE 7: Flood Loads

The NFIP regulations establish a performance statement for buildings, requiring that buildings in SFHAs be "designed (or modified) and adequately anchored to prevent flotation, collapse, or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy."

ASCE 7 *Minimum Design Loads for Buildings and Other Structures* is referenced by the I-Codes. Loads defined as "forces or other actions that result from the weight of all building materials, occupants and their possessions, environmental effects, differential movement, and restrained dimensional changes." ASCE 7 provides minimum load and combination load requirements for dead loads, live loads, flood loads, wind loads, seismic loads, snow loads, rain loads, and ice loads. Loads and appropriate load combinations are developed to be used together and are set forth for strength design and allowable stress design.

The basic requirement of a building code is that buildings and structures must be designed and constructed to support the factored loads in load combinations without exceeding the appropriate strength limit states for the materials used in the construction. In short, buildings must be designed to resist anticipated loads, where the anticipated loads are prescribed based on local conditions.

For flood loads, ASCE 7 includes a performance statement that is equivalent to performance statement in the NFIP regulations: "Structural systems of buildings or other structures shall be designed, constructed, connected, and anchored to resist floatation, collapse, and permanent lateral displacement due to action of flood loads associated with the design flood and other loads in accordance with load combinations [specified in ASCE 7]."

Flood loads include hydrostatic loads, hydrodynamic loads, wave loads (with specifics for breaking wave loads on vertical pilings and columns, on vertical walls, on non-vertical walls, and from obliquely incident waves), and impact loads (from debris and ice). ASCE 7 requires the effects of erosion and scour to be included in load calculations (basically by assuming loss of soil, which increases depth of water, thus increasing flood loads).

4.4 ASCE 24: Flood Resistant Design and Construction

ASCE 24 *Flood Resistant Design and Construction* was first published in 1998 and republished in 2005 (a revision is expected late 2013). IBC Section 1612.4 references ASCE 24 for all of the specific design and construction requirements that apply to buildings and structures in flood hazard areas. The IRC requires homes in floodways to be designed in accordance with ASCE 24 and allows use of ASCE 24 for homes in Zone V.

Building codes reference many standards. Standards are developed by qualified organizations according to prescribed procedures. The American Society Civil Engineers appoints a balanced committee that includes regulators, design professionals, manufacturers, and builders. The process requires the committee to evaluate and vote on proposed changes. For ASCE 24, the result is a consensus document that represents what the committee agrees is necessary and appropriate for buildings and structures to resist flood loads and minimize flood damage. In the past, the committee determined that exceeding a number of the minimum requirements of the NFIP was necessary to achieve the desired performance.

4.5 ASCE 24: Minimum Elevation Requirements

NFIP. NFIP regulations require buildings in SFHAs to be elevated to be reasonably safe from flooding and to reduce flood damage. In Zone A, the lowest floor must be at or above the BFE. In Zone V, the bottom or the lowest horizontal structural member of the lowest floor must be at or above the BFE. Nonresidential buildings in Zone A can be dry floodproofed to the level of the BFE rather than elevated.

IBC/ASCE 24. The IBC, by reference to ASCE 24, specifies the minimum elevations to which buildings must be elevated or floodproofed. Every building designed under the IBC must be assigned an Occupancy Category, which is a way to recognize the importance of buildings in terms of protection of occupants as well as protection of function. ASCE 24 uses Occupancy Category to establish minimum elevations for buildings in flood hazard areas. Tables in several sections (summarized on the next page) specify minimum elevations for lowest floors (in Zone A and Zone V), floodproofing, flood damage-resistant materials, utilities, and equipment. All buildings are required to be 1 or 2 ft higher than the BFE/DFE, except agricultural facilities, temporary facilities, and minor storage facilities. Importantly, homes that are within the scope of the IBC and homes in floodways are required to be at least 1 ft higher than the BFE.

From ASCE 24, used with permission of ASCE.

		Category I	Category II	Category III	Category IV
Elevation of Lowest Floor (A Zone: Table 2-1)	All A Zones not identified as Coastal A Zones: elevation of lowest floor	DFE	BFE +1 ft or DFE, whichever is higher	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher
Elevation of Bottom of Lowest Horizontal Structural Member (V Zone: Table 4-1)	All V Zones and Coastal A Zones: where the lowest horizontal structural member is parallel to direction of wave approach	DFE	DFE	BFE +1 ft or DFE, whichever is higher	BFE +1 ft or DFE, whichever is higher
	All V Zones and Coastal A Zones: where the lowest horizontal structural member is perpendicular to direction of wave approach	DFE	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher
Elevation Below Which Flood-Damage-Resistant Materials Shall be Used (Table 5-1)	All A Zones not identified as Coastal A Zones	DFE	BFE +1 ft or DFE, whichever is higher	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher
	All V Zones and Coastal A Zones: where the lowest horizontal structural member is parallel to direction of wave approach	DFE	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher
	All V Zones and Coastal A Zones: where the lowest horizontal structural member is perpendicular to direction of wave approach	DFE	BFE +2 ft or DFE, whichever is higher	BFE +3 ft or DFE, whichever is higher	BFE +3 ft or DFE, whichever is higher
Minimum Elevation of Utilities and Equipment (Table 7-1)	All A Zones not identified as Coastal A Zones	DFE	BFE +1 ft or DFE, whichever is higher	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher
	All V Zones and Coastal A Zones: where the lowest horizontal structural member is parallel to direction of wave approach	DFE	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher
	All V Zones and Coastal A Zones: where the lowest horizontal structural member is perpendicular to direction of wave approach	DFE	BFE +2 ft or DFE, whichever is higher	BFE +3 ft or DFE, whichever is higher	BFE +3 ft or DFE, whichever is higher
Dry Floodproofing of non-residential structures and non-residential portions of mixed-use buildings (Table 6-1)	All A Zones not identified as Coastal A Zones: elevation to which dry floodproofing extends	BFE +1 ft or DFE, whichever is higher	BFE +1 ft or DFE, whichever is higher	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher
	All V Zones and Coastal A Zones: dry floodproofing not allowed	Not permitted	Not permitted	Not permitted	Not permitted

4.6 ASCE 24: Pile Foundations

NFIP. The NFIP regulations require buildings in coastal high hazard areas (Zone V) to have pile or column foundations and require registered design professionals to develop or review the structural design, specifications and plans for construction. The design and methods of construction used must be certified as being in accordance with accepted standards of practice for meeting the provisions of the regulations. ASCE 24 sets forth accepted standards of practice.

IBC/ASCE 24. ASCE 24 has extensive and detailed specifications for pile foundations. Geotechnical considerations must account for instability and decreased structural capacity associated with erosion, scour, and shoreline movement, which must be considered when designers specify foundation depths. Specifications are provided for different types of piles (wood, steel H, concrete-filled steel pipe, pre-stressed concrete, precast concrete, cast-in-place concrete) and aspects of foundation design, including lateral resistance, capacity of supporting soils, minimum penetration, pile spacing, pile caps, grade beams, pile splicing, and connections. Footings, mats, rafts, grade beams, and slabs-on-grade are permitted at or below grade. Bracing specifications include limitations based on orientation relative to the primary direction of wave forces.

4.7 ASCE 24: Dry Floodproofing Performance and Limitations

Dry floodproofing is permitted only for nonresidential buildings. ASCE 24 defines the terms "residential" and "nonresidential." Nonresidential buildings may be dry floodproofed with a combination of structural and nonstructural measures that reduce flood damage by preventing the entry of water. To be successful, buildings have to be designed to resist flood loads, especially the weight of water (hydrostatic load) and the effects of buoyancy. Like a boat, when surrounding soils become saturated, a watertight building can float if it is not designed to resist the effects of buoyancy.

NFIP. The NFIP regulations define "floodproofing" by describing the required performance of measures that may be used to make buildings "watertight" to reduce or eliminate flood damage. The NFIP regulations require certification by a registered design professional that floodproofing designs are "in accordance with accepted standards of practice." FEMA Technical Bulletin #3 *Non-Residential Floodproofing – Requirements and Certification* offers guidance on dry floodproofing. The NFIP only requires dry floodproofing measures to extend to the BFE.

IBC/ASCE 24. The IBC definition of "dry floodproofing" is similar to the NFIP definition, with the addition of a specific requirement that structural components have the capacity to resist loads identified in ASCE 7. IBC Section 1612.4 refers to ASCE 24 where dry floodproofing is addressed in Section 6.2, including several specific requirements and limitations. Dry floodproofed buildings are:

- Permitted only in Zone A (specifically, outside of high-risk flood hazard areas, coastal high hazard areas, and Coastal A Zones).
- Not permitted where flood velocities exceed 5 ft/sec.
- Required to have at least one exit door above the design flood elevation.

- Allowed where warning time is a minimum of 12 hours unless a community's warning system provides sufficient time for persons who are responsible for implementing the floodproofing measures to get to the site, to install or activate measures, and to evacuate all occupants.
- Required to have a flood emergency plan, approved by the community and posted in at least two conspicuous locations, that addresses specified elements and actions.
- Elevation of the floodproofing measures is a function of Occupancy Category: for Category II and III, the minimum protection elevation is BFE +1 ft or DFE (whichever is higher); for Category IV, the minimum protection elevation is BFE + 2 ft or DFE (whichever is higher).

5 Existing Buildings

5.1 Existing Buildings: NFIP

The NFIP requires participating communities to review permits for all proposed construction to determine if activities will be in special flood hazard areas. For buildings and structures in SFHAs, communities are required to ensure that new construction and Substantial Improvements meet the requirements to minimize flood damage:

- The term "new construction" includes not only proposed new buildings and structures, but any building that was built after the date of the community's first floodplain management regulations, and any subsequent improvements to such buildings. Work on compliant buildings must be performed in a manner that ensures continued compliance with the floodplain management requirements that those buildings had to meet when they were built.
- The term "Substantial Improvement" includes work on existing buildings, including additions, improvements, rehabilitation, alterations and repairs, if the cost of the work equals or exceeds 50% of the market value of the building before the improvement is started or before the damage occurred.

For more guidance, see *Substantial Improvement/Substantial Damage Desk Reference* (FEMA P-758).

5.2 Existing Buildings: I-Codes and ASCE 24

IRC. The IRC applies to the "construction, alteration, movement, enlargement, replacement, repair, equipment, use and occupancy, location, removal and demolition" of homes within the scope of the code. The code requires that additions, alterations, and repairs conform to the requirements for new structures, unless otherwise stated. The administrative provisions require a finding regarding the cost of work and a determination whether work on existing homes is Substantial Improvement. The IRC does not have any specific "higher standards" that specifically apply to existing homes in flood hazard areas: if such homes are substantially improved, then the IRC requirements for new construction apply, including the requirement to use ASCE 24 if existing homes are in floodways.

IBC/ASCE 24. The IBC also applies to work on existing buildings. It specifies that work on an existing building shall not cause the building to be in violation and that portions not affected by the work do not have to be brought into compliance, unless otherwise required. Specifically for buildings in flood hazard areas, Section 1612 applies to all new construction of buildings, structures, portions of buildings and structures, and Substantial Improvement and restoration of Substantial Damage. Similarly, ASCE 24 applies to new structures and subsequent work on such structures, and work classified as Substantial Improvement (including repair of Substantial Damage) of existing structures. The IBC and ASCE 24 do not contain any specific "higher standards" that specifically apply to existing buildings in flood hazard areas: if such buildings are substantially improved, then the requirements for new construction apply.

IBC Chapter 34 applies to existing buildings. It has separate sections for additions (increase in floor area or height), alterations, repairs, and historic buildings. Each section includes a requirement that if the work constitutes Substantial Improvement, or repair of Substantial Damage, then the work must comply with Section 1612 and the existing building is required to be brought into compliance with the requirements for new buildings in flood hazard areas. A section on moved structures requires such structures to comply with the code requirements for new structures.

IBC Chapter 34 also applies to historic buildings, as such buildings are defined in IBC Section 202. In general, the requirements of the code do not apply to work on historic buildings if the buildings do not constitute a "distinct life safety hazard" as judged by the building official. However, IBC Section 3409.2 specifies that, in flood hazard areas, if the work proposed constitutes Substantial Improvement (including repair of Substantial Damage), then historic buildings are required to be brought into compliance with IBC Section 1612 unless the buildings qualify under the exception. The exception for historic structures is provided for consistency with the NFIP definition for "Substantial Improvement."

IEBC. The IEBC applies to the repair, alteration, change of occupancy, addition, and relocation of existing buildings. The IEBC includes the requirement that if work on an existing building in flood hazard areas constitutes Substantial Improvement or repair of Substantial Damage, the building is required to be brought into compliance with the requirements of the IBC Section 1612. The IEBC does not have any "higher standards" that apply specifically to existing building, although it has more specific tests for additions (next section).

5.3 Additions: Structurally Connected or Not Structurally Connected

NFIP. The NFIP regulations do not have specific requirements that specify when existing buildings are, or are not, required to be brought into compliance if new additions are proposed to increase their floor areas. NFIP guidance has long referred to whether the common wall between an existing building and an addition is modified by more than a doorway. The implication is that such minor modification does not alter the load-bearing structure of the existing building and the addition has its own supporting foundation. Guidance in Chapter 6 of FEMA P-758 is more specific, laying out when additions must comply, and when additions plus the base building must be brought into compliance. Whether an addition is or is not structurally connected, and whether the building is pre-FIRM or post-FIRM, are the factors that determine whether the base building is required to be brought into compliance. If structurally connected, flood loads imposed on a

non-elevated addition would impart loads on the base building. If an addition has a separate foundation (i.e., not structurally connected), then the addition can be elevated without requiring the base building to be brought into compliance. The caveat is, if the base building is post-FIRM, then all work must conform to the NFIP regulations regardless of the scope or cost of the work.

IRC and IBC/ASCE 24. The codes, like the NFIP regulations, do not have specific requirements that distinguish when existing buildings in flood hazard areas must be brought into compliance as a function of additions, other than if the work is determined to constitute Substantial Improvement.

IEBC. Section 1003.5 of the IEBC has more specific provisions than the NFIP (and the IRC and IBC) for horizontal additions that are or are not structurally connected and for vertical additions. The guidance in FEMA P-758 described above is consistent with these specific provisions.

6 Building Code Resources

Building Code Resources: Flood Resistant Provisions of the 2009 I-Codes, Flood Resistant Provisions of the 2012 I-Codes, Highlights of ASCE 24, and Provisions of the 2009 I-Codes and ASCE 24 Compared to the NFIP: http://www.fema.gov/building-science/building-code-resources.

FEMA Technical Bulletins:
http://www.fema.gov/plan/prevent/floodplain/techbul.shtm.

FEMA P-758. *Substantial Improvement/Substantial Damage Desk Reference.* Order hardcopy from the FEMA Warehouse (800-480-2520) or download:
http://www.fema.gov/library/viewRecord.do?id=4160.

7 Brief Notes on Other Requirements of ASCE 24

Decks, concrete pads, and patios (V Zone and Coastal A Zone). ASCE 24 includes specifications for decks, concrete pads, and patios that are beneath or adjacent to structures in coastal high-hazard areas and Coastal A Zones, including specific requirements that reinforcing not be used and limiting pad thickness [Sec. 4.8]. IRC requires slabs, pools, pool decks, and walkways to be structurally independent of buildings, unless building foundation are designed to resist the additional flood load [IRC 322.3.3].

Platforms for utility equipment. ASCE 24 requires that exterior elevated platforms be supported on piles or columns, or cantilevered from or knee-braced to the structure. If piles or columns are used, they are required to be adequately embedded to account for erosion and local scour [Sec. 7.1].

Electric components required to meet life safety requirements. ASCE 24 has specifications for exposed conduits and cables, electric meters, disconnect switches and circuit breakers, and other electric elements below the minimum elevations, including a statement that electric elements required to meet life safety provisions may be permitted within certain limitations [Sec. 7.2].

Duct systems. ASCE 24, IMC, and IRC each specifically require ductwork/duct systems to be above the required elevations [Sec. 7.4; M602.4, M603.13; IRC 322.1.6; IRC 1601.4.9].

Underground plumbing system elements. ASCE 24 specifies that if installed under-ground, piping and plumbing systems shall be buried to a depth sufficient to prevent movement, separation, or loss due to flooding and erosion [Sec. 7.3.1].

Tanks. ASCE 24 requires tanks to be elevated or installed to resist flood loads, and have fill openings and vents elevated. Designs are required account for 1.5 times the potential buoyant and other flood forces acting on an empty tank during design flood conditions [Sec. 7.4.1].

Pools. ASCE 24 requires all pools to be designed to withstand all flood-related loads and load combinations. Pools in coastal high hazard areas and Coastal A Zones are required to be elevated, designed to breakaway, or to remain in the ground without obstructing flow [Sec. 9.5].

8 Brief Notes on IBC Appendix G

IBC Appendix G is an optional appendix. It is intended to fulfill the floodplain management and administrative requirements of the NFIP that are not included in the body of code. Communities that adopt the code and this appendix without modification meet the minimum requirements of the NFIP, provided all development is regulated, including buildings exempt from the code. Appendix G includes administrative requirements of NFIP and requirements concerning modifications to watercourses, permits for flood hazard area development other than buildings, conditions for the issuance of variances from floodplain management requirements and site improvements, subdivision planning and installation of manufactured homes, recreational vehicles, tanks, temporary structures and, temporary storage, and Utility and Miscellaneous Group U structures. Some states do not adopt Appendix G, some states adopt it as a mandatory appendix, and some states allow local jurisdictions to adopt it.

Provisions of Appendix G that exceed or that are more specific than the NFIP minimum requirements include the following:

Subdivisions. IBC Appendix G requires residential building lots to be provided with buildable area outside of the floodway [IBC G301.2(3)].

Recreational vehicles. IBC Appendix G prohibits placement of recreational vehicles in flood hazard areas subject to high-velocity wave action (Zone V) and in floodways [G601.1].

Tanks. IBC Appendix G requires tanks to be anchored to prevent flotation, collapse, or lateral movement (underground and above-ground) or elevated; requires tank inlets and vents to be at or

above DFE or fitted with covers to prevent inflow of floodwaters and outflow of contents [IBC G701].

Fences. IBC Appendix G requires fences in floodways that may block the passage of floodwaters, such as stockade fences and wire mesh fences, to meet the requirements for floodway encroachments in G103.5 [IBC G801.2].

Prefabricated swimming pools. IBC Appendix G requires that prefabricated swimming pools in floodways meet the requirements for floodway encroachments in G103.5 [IBC G801.5].

Temporary structures and temporary storage. IBC Appendix G requires temporary structures to be anchored to prevent flotation, collapse, or lateral movement; specifies that stored materials shall not include hazardous materials; and requires temporary structures and temporary storage in floodways to meet the requirements for floodway encroachments in G103.5 [IBC G901].

Appendix A: Examples of State and Local Amendments

Florida. As part of the State's 2010 initiative to retain the flood provisions of the I-Codes in the Florida Building Code, and to allow communities to adopt procedures to grant variances, to retain higher floodplain management standards that are already adopted, and to adopt new higher standards, the State statute was changed so that local code amendments for floodplain management will not sunset every 3 years when a new edition of the Florida Building Code is adopted by the State. In addition, the Florida Building Code refers to local floodplain management ordinances for adoption of flood hazard maps. As of mid-2013, nearly half of the 458 NFIP communities had adopted or are in the process of adopting the model, and the remaining were expected to follow suit. Florida's code-coordinated ordinance, frequently asked questions, and model language for higher standards is online at http://www.floridadisaster.org/Mitigation/SFMP/lobc_resources.htm.

New York. Citing reduced damage, the potential for compliant buildings to be flooded as impervious areas increase in upper watersheds, the potential for future BFE increases as floodway fringe areas are developed, and economic benefits of lower flood insurance premiums and additional credits in CRS communities, the New York State Department of Environmental Protection proposed the addition of 2 ft to the elevation requirement in the residential code. The proposal was adopted for the 2010 code by the State Fire Prevention and Building Code Council and will be carried forward to future editions of the code.

Oregon. Oregon modified the codes to clarify that building departments shall permanently retain copies of all permits issued in flood hazard areas, along with copies of design certifications and inspection reports. The State also amended the residential code by adding 1 ft to the elevation requirement (even in Zone AO), while also allowing communities to specify even more additional elevation. Oregon developed a model floodplain management ordinance designed to coordinate with the codes. The State Coordinator expects many communities to replace their floodplain management regulations with the new code-coordinated ordinance.

Rhode Island. The State modified the residential code to require copies of applications for variances to be forwarded to the NFIP State coordinating agency. To coordinate with the codes, Rhode Island developed a new floodplain management model ordinance that references the building codes and does not include any provisions for design and construction of buildings (other than detached accessory structures). The State Coordinator indicates many communities are adopting the model because in most communities, building codes and floodplain management regulations are enforced by the same official.

Virginia. Virginia does not allow communities to amend the code. However, State statute specifies that the building code shall not supersede local floodplain regulations, thus allowing locally adopted higher standards. The statute and building code are clear that while farm buildings and structures do not require a building permit, they are still subject to local floodplain management regulations. Virginia amended the building code to include provisions for manufactured homes, thus requiring foundation designs to be prepared by a registered design professional (the provisions also permits 36-inch piers for homes installed on sites in existing

parks and subdivisions, provided no home on the same site has sustained Substantial Damage from flooding).

Austin, TX. Upon adoption of codes based on the I-Codes, the City of Austin eliminated its floodplain management regulations. The codes were amended to specifically require use of the FEMA Elevation Certificate, to specify that the design flood is based on "projected full development," to treat areas subject to the 4-percent or greater chance of flooding (25-year flood) as floodways, to specify cumulative Substantial Improvements over a 10-year period, and to add an additional foot to the minimum lowest floor elevation requirements. Austin also adopted IBC Appendix G and modified the elevation requirements for manufactured homes to add an additional foot.

Appendix B: Adopting Higher Standards in the I-Codes

States and communities that are considering modifying the I-Codes are advised to consult with the appropriate FEMA Regional Office for assistance. The following suggestions should be reviewed carefully. Sample language for incorporating these higher standards that affect buildings will be included in the upcoming revision to *Reducing Flood Losses Through the International Code Series* (due late 2013). Florida State Floodplain Management Office developed model code amendment language for additional elevation (freeboard), regulating CAZ like Zone V, cumulative substantial damage, and treating specifically defined repetitive (flood) loss properties as Substantial Damage to qualify for NFIP insurance coverage called Increased Cost of compliance. The model code amendment language is available online at http://www.floridadisaster.org/Mitigation/SFMP/lobc_resources.htm.

Additional Elevation Requirement (Freeboard). Buildings that are elevated higher than the minimum requirements have additional protection (a factor of safety) that accounts for some of the uncertainty in modeling methods. The reality is floods can and do rise higher than the BFE, and development is continuing in upstream watersheds. Additional complications are climate change and sea level rise, subsidence, and other factors. These factors make it difficult to estimate water surface elevations for specific frequency events. The I-Codes already include some freeboard, especially by reference to ASCE 24. When selecting additional height as a code requirement, or voluntarily by a building designer or owner, it is important to note that the degree of added protection will vary from location to location. Elevating 1 ft higher in an area where the depth of flooding during the base flood already is deep does not provide the same protection as elevating an additional foot in an area where the base flood depth is shallow. The most effective way to incorporate freeboard into the IRC to ensure that designers and builders are aware of the requirement is to amend the code in every section that cites the DFE, as appropriate. The most commonly specified additional height is + 1 ft.

Regulate CAZ as Coastal High Hazard Areas (Zone V). IBC, by reference to ASCE 24, already requires buildings in Coastal A Zones to comply with the requirements for Zone V. In terms of allowable foundation types and enclosures, the 2009 and 2012 IRC treats CAZs like Zone A, with the addition of 1 ft of freeboard, but only if a CAZ is designated. CAZs are designated if the FIRM shows the Limit of Moderate Wave Action or if a community adopts a designation, which typically takes the form of a distance from the Zone V boundary or a geographic limit such as a road that parallels the shoreline. Because FIRMs show CAZ as Zone A, to modify the IRC to treat CAZ the same as Zone V, the section that applies in Zone A must be modified to refer to the section that applies to Zone V.

Cumulative Substantial Improvement. The NFIP and building codes require communities to determine if work proposed on existing buildings is Substantial Improvement or repair of Substantial Damage and to require Substantially Improved and Substantially Damaged buildings to be brought into compliance with the flood requirements for new construction. The determination is made each time work is proposed, which can be exploited by owners who phase improvements to avoid triggering the Substantial Improvement / Substantial Damage requirements by submitting successive permit applications. Some communities elect to

accumulate costs over the life of a building, although specific time periods are more common (e.g., 1, 5, or 10 years). A more complete description is in *Substantial Improvement/Substantial Damage Desk Reference* (FEMA P-758).

Repetitive Loss Flooding. Federal flood insurance includes coverage called Increased Cost of Compliance (ICC). NFIP-insured buildings that are located in special flood hazard areas and that are determined to meet the basic definition of "Substantial Damage" due to damage by flooding are eligible to file an ICC claim for up to $30,000 towards the cost of bringing the building into compliance with the floodplain management requirements for new construction. In communities that adopt specific language for "repetitive loss" structures, such structures that are NFIP-insured may also be eligible for the ICC claim even if they do not meet the standard 50% threshold for Substantial Damage by a single event. To qualify, communities must adopt and enforce the provision on all buildings, not just those that are covered by Federal flood insurance. The specific language that defines "repetitive loss" is specified in the Federal law that authorized the ICC coverage.

Prohibit Enclosures Below Elevated Buildings. Flood hazard areas are subject to considerable forces that may be exerted on the foundation system and any portion of a building that extends below the DFE. Enclosures below otherwise properly elevated buildings are permitted under the NFIP and the I-Codes, provided the enclosures meet certain provisions. However, to minimize obstructing flow and damage that can still be sustained, and also to minimize the amount of debris contributed to floodwaters, some communities choose to prohibit enclosures below elevated buildings altogether.

Limit the Size of Enclosures Below Elevated Buildings. Limiting the size of enclosures below elevated buildings is another way to minimize flood damage and reduce the quantity of building materials that become debris that can damage other buildings. The NFIP and the I-Codes allow such enclosures that are used solely for parking of vehicles, building access, and storage. No other uses are permitted. Enclosures for access and storage need not be large, otherwise owners may be tempted to convert the areas to uses that are not allowed, such as bedrooms, family rooms, bathrooms, and workshops. In coastal high hazard areas (Zone V), flood insurance policies for buildings with enclosures that are larger than 300 sq ft are more expensive. Many communities require property owners to sign nonconversion agreements to acknowledge the use restrictions and to agree not to convert enclosures below elevated buildings (some communities require such agreements to be recorded on property deeds to inform future owners of the use limitations).