SPIKOWSKI
PLANNING
ASSOCIATES

MEMORANDUM

TO: Fort Myers Beach Town Council
FROM: Bill Spikowski
DATE: September 20, 2006
SUBJECT: Introduction of Proposed LDC Amendments, October 9, 2006

On September 12, the Local Planning Agency held a public hearing to consider an ordinance amending the town's land development code.

These amendments would affect the floodplain regulations in Chapter 6 of the code and related provisions on building heights in Chapter 34. Many of these amendments originated at a Town Council workshop held on March 22, 2006; others are based on suggestions from town staff and the public since that workshop.

The floodplain regulations in Chapter 6 are unique in that FEMA requires that they be adopted and continually enforced by the town in order for property owners within the town to be eligible to purchase federal flood insurance. As a result, FEMA retains the final authority to evaluate this portion of the code's compliance with requirements of its National Flood Insurance Program (NFIP).

The attached ordinance reflects the formal recommendations of the Local Planning Agency.

Here is a summary of the proposed code amendments:

- **6-405:** The phrase "enclosed area" would be changed to "enclosed space" to match the language used throughout this chapter of the code. The term "highest adjacent grade" would be redefined slightly to better fit its usage in this chapter.

- **6-441:** The assignment of the "flood insurance coordinator" role would be modified to match similar changes made to the remainder of the code by Ordinance 05-07.

- **6-444:** Recent experience has demonstrated that better testing and reporting is needed to ensure that commercial buildings constructed with "dry floodproofing" are protected from actual flooding by proper installation of flood barriers over doors and windows.

- **6-472(1):** The existing wording has caused some confusion during the permitting process between subsections (1) and (5).

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- **6-472(2) and(3):** Minor editorial changes would clarify several provisions.

- **6-472(4):** "Dry floodproofing" is permitted for nonresidential buildings under certain circumstances (see pages 4–9 though 4–17 of the Fort Myers Beach Comprehensive Plan for a discussion of this subject). The proposed changes would clarify these provisions, in conjunction with similar changes to 6-444.

- **6-472(5)a. and b.:** These subsections contained confusing language that would could be read to allow practices that are forbidden by NFIP, particularly as to the type of construction allowed below the minimum flood elevation (known as "base flood elevation" or BFE) and as to the allowable uses of enclosed space at ground level.

  The town has latitude as to whether to permit or forbid enclosed space below base flood elevation. However, if space is enclosed, it can only be used for parked vehicles, building access, and storage. (Near the beach, enclosures must use "breakaway" walls that will fail when struck by waves or high winds in order to preserve the building above.)

  The proposed language would eliminate the confusion by putting the town's decision on the amount of enclosed space below elevated buildings into subsection (5)a. and putting the NFIP-mandated regulations into subsection (5)b.

  The existing code restricts the amount of space that can be enclosed because of the local history of such space being converted to finished living space in violation of federal regulations (and conversion into separate living quarters in violation of town zoning). At the March workshop, the Town Council expressed a desire to eliminate restrictions on enclosed space below flood elevation and to deal with violations through much stricter code enforcement. Language to eliminate restrictions on the amount of enclosed space is found in Alternative a-3; other alternatives are shown in this draft as a-1 and a-2.

- **6-472(5)c.1:** This subsection would now contain clearer language regarding the architect/engineer certification requirements to meet minimum NFIP standards.

- **6-472(5)c.1. and c.5.:** These subsections would now contain references to NFIP technical bulletins to assist builders in complying with these regulations. Copies of these documents are attached to this memorandum.

- **6-472(5)c.2.:** Three alternatives have been drafted to address electrical and plumbing connections below flood elevations. Alternative 2-a is the status quo, a very strict regulation against any utility connections; this same regulation applies in unincorporated Lee County. Alternative 2-b is similar but provides an exception where service connections are required below flood elevation (e.g., the height of electric meters is set by the National Electrical Code for the convenience of meter readers, notwithstanding potential damage during floods). Alternative 2-c is the most lenient allowed by NFIP

regulations; instead of forbidding utility connections, design requirements would prevent infiltration or accumulation of floodwater within components such as the metal boxes that house electric meters. If selected, the latter two alternatives would contain a reference to an NFIP book that provides considerable detail on methods for protecting utilities from flood damage.

- **6-472(5)c.3.:** This subsection was confusing to permitting staff and has been rewritten for clarity.

- **6-472(5)c.4.:** The current regulations strictly forbid partitions within enclosed space below base flood elevation. Substantially the same regulation applies in unincorporated Lee County (except for the prohibition on air conditioning), and is also found in the model ordinance recommended by state emergency management officials.

  Under the current wording, partitions are not allowed between a garage and the stairway up to the habitable space, or between a garage and a storage room. Alternative 4-a would retain this restriction; 4-b would be as lenient as allowed by NFIP regulations as to partitions, but would retain the town's restriction on air conditioning, which was imposed to hinder future conversion to living quarters. Alternative 4-c was added and endorsed by the LPA to eliminate the restriction on air conditioning.

- **6-472(5)c.6. and 7.:** Minor editorial changes are proposed for both subsections.

- **6-472(6):** The proposed change would reduce the extent of accessory structures such as clubhouses that could ignore the elevation requirements. In the case of large hotels or multifamily buildings, the current wording would allow very extensive accessory structures to be built at ground level simply because their value was less than 10% of the principal building. The LPA modified the original redraft of this subsection to provide a sliding scale of values for various types of buildings.

- **6-472(7):** These regulations apply to lots near the beach that are designated as "V zones." This terminology is based on protecting buildings from the "velocity" of waves that could strike buildings near the beach. Most of the proposed changes are editorial in nature; however, subsection (7)n. repeats an NFIP minimum standard.

- **34-631(a)(1)b.:** It is possible that existing or future elevation requirements may place the first habitable floor of some buildings higher than the 16' maximum in this subsection. If so, the new wording would avoid a contradiction with the Chapter 6 regulations.

- **34-631(a)(2)c.:** Properties seaward of the 1991 coastal construction control line generally have state-mandated elevation requirements that are higher than those shown on the maps provided by FEMA. New language is proposed here that would measure building heights from the higher of the two mandatory elevations.

- **34-631(a)(2)d.:** FEMA recently released maps showing proposed increases in flood elevations across the entire island. New language here would allow property owners the option to build to the higher elevations now without getting penalized by having their building height capped by being measured from the existing lower elevations.

At the end of the public hearing on September 12, the LPA adopted a motion unanimously finding this ordinance to be consistent with the Fort Myers Beach Comprehensive Plan and recommending its approval in accordance with its specific suggestions (which have been indicated in the September 20 draft of this ordinance). Bob Simon and Rochelle Kay were absent.

This proposed ordinance is scheduled to be introduced before the Town Council on October 9. Two public hearings need to be held by the Town Council before the ordinance could be adopted.

For your information, several FEMA publications are attached. The first two are referenced in the proposed ordinance. Two others explain important concepts regarding the protection of utilities, and also walls that enclose space below flood elevations. These publications refer to various NFIP regulations but they also contain non-regulatory "best practice" advice to builders. Note the use of the term "Design Flood Elevation" (DFE), which is the height of flooding that a building is designed to withstand. This height can be different than BFE – communities without floodplain regulations have no BFEs established; in communities with BFEs established, buildings can be designed for greater flood protection than the minimum regulatory standards.

cc: FEMA Technical Bulletins 1-93 and 2-93
"Protecting Utilities," FEMA Technical Fact Sheet No. 28
"Enclosures and Breakaway Walls," FEMA Technical Fact Sheet No. 27

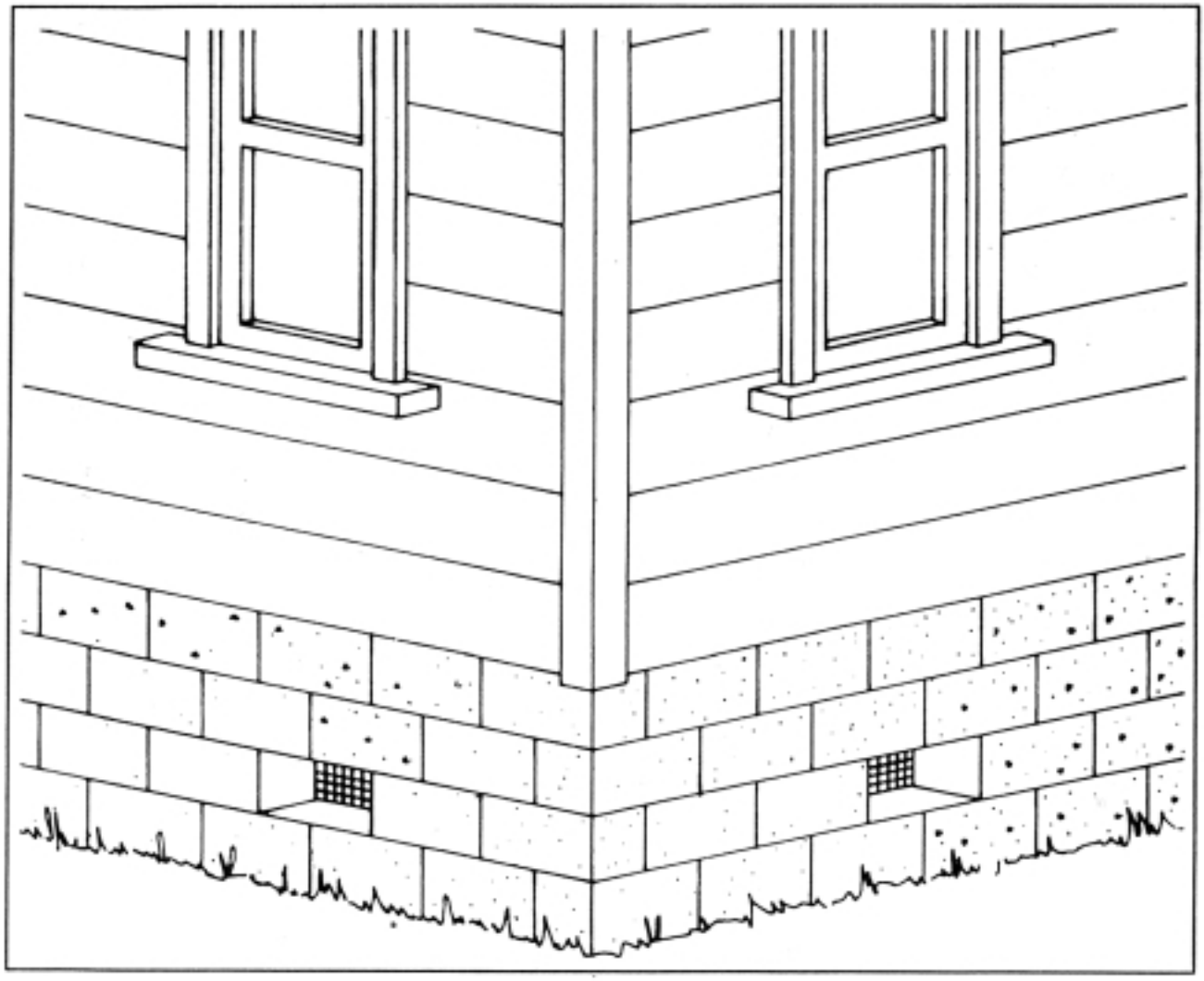
Technical Bulletin 1-93

Openings in Foundation Walls

for Buildings Located in Special Flood Hazard Areas

in accordance with the

National Flood Insurance Program



FEDERAL EMERGENCY MANAGEMENT AGENCY
FEDERAL INSURANCE ADMINISTRATION

FIA-TB-1
(4/93)

Key Word/Subject Index:

This index allows the user to quickly locate key words and subjects in this Technical Bulletin. The Technical Bulletin User's Guide (printed separately) provides references to key words and subjects throughout the Technical Bulletins. For definitions of selected terms, refer to the Glossary at the end of this bulletin

Any comments on the Technical Bulletins should be directed to:

FEMA/FIA
Office of Loss Reduction
Technical Standards Division
500 C St., SW, Room 417
Washington, D.C. 20472

Technical Bulletin 1-93 replaces Technical Bulletin 85-2 (draft) "Foundation Wall Openings."

Graphic design based on the Japanese print *The Great Wave Off Kanagawa*, by Katsushika Hokusai (1760-1849), Asiatic collection, Museum of Fine Arts, Boston.

TECHNICAL BULLETIN 1-93

Openings in Foundation Walls Required for Buildings Located in Special Flood Hazard Areas in accordance with the National Flood Insurance Program

Introduction

An important objective of the National Flood Insurance Program (NFIP) is to protect buildings constructed in floodplains from structural damage caused by flood forces. In support of this objective, the NFIP regulations include building design criteria that apply to new construction and substantial improvements of existing buildings in Special Flood Hazard Areas (SFHAs). According to these criteria, residential buildings constructed in A zones (Zones A, AE, A1-A30, AR, A0, and AH) must have their lowest floors at or above the base blood elevation (BFE). Non-residential buildings constructed in A zones must either have their lowest floors at or above the BFE or be dry floodproofed (made watertight) to or above the BFE. Residential and non-residential buildings whose lowest floors have been constructed at or above the BFE usually are elevated on piers, columns, piles, extended foundation walls, or fill. While the main portion of such a building is protected from the 100-year and lesser-magnitude floods, the foundation and any enclosures below the BFE used for parking, building access, or limited storage will be exposed to flood forces.

For buildings constructed on extended foundation walls or that have other enclosures below the BFE, these flood forces include the hydrostatic pressure of floodwaters against the foundation or enclosure walls. If the walls are not designed to withstand hydrostatic pressure, they can be weakened or can fail and the building damaged. Therefore, the NFIP regulations require that foundation and enclosure walls that are subject to the 100-year flood contain openings that will permit the automatic entry and exit of floodwaters. These openings allow floodwaters to reach equal levels on both sides of the walls and thereby lessen the potential for damage from hydrostatic pressure. The requirement for openings applies to all new and substantially improved buildings in A zones. This Technical Bulletin explains the requirement for openings and provides guidance for designing and constructing foundation and enclosure walls that include the required openings.

Extended foundation and enclosure walls below the BFE may also be threatened by hydrodynamic forces resulting from velocity flows and debris impact. The requirement for openings is intended to reduce flood damage associated with hydrostatic not hydrodynamic forces. These forces are described within this bulletin, and additional design guidance is given for buildings in areas subject to velocity flood flows, which may include debris.

For buildings in V zones (Zones V, VE, and V1-V30), more stringent design and construction requirements have been established for the portions of the buildings below the BFE. For information on V-zone design and construction requirements, refer to the NFIP regulations, the Technical Bulletin series, and FEMA's "Coastal Construction Manual."

NFIP Regulations

The NFIP regulations require that all enclosures below the BFE in A zones be designed to allow for the automatic equalization of hydrostatic forces during a flood event. Section 60.3(c)(5) of the NFIP regulations states that a community shall:

> ***"Require, for all new construction and substantial improvements, that fully enclosed areas below the lowest floor that are usable solely for parking of vehicles, building access, or storage in an area other than a basement and which are subject to flooding shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwaters. Designs for meeting this requirement must either be certified by a registered professional engineer or architect or meet or exceed the following minimum criteria: A minimum of two openings having a total net area of not less than one square inch for every square foot of enclosed area subject to flooding shall be provided. The bottom of all openings shall be no higher than one foot above grade. Openings may be equipped with screens, louvers, valves, or other coverings or devices provided that they permit the automatic entry and exit of floodwaters."***

As stated in the regulations, buildings in A zones that are substantially damaged and/or substantially improved must meet all the NFIP requirements for new construction, including the openings requirement. All design plans for substantial improvements to buildings in A zones must be thoroughly reviewed by the community to ensure compliance with the openings requirement. Further information on substantial damage and substantial improvement may be found in the FEMA publication "Answers to Questions About Substantially Damaged Buildings."

It should be noted that Technical Bulletins provide guidance on the minimum requirements of the NFIP regulations. Community or State requirements that exceed those of the NFIP take precedence. Design professionals should contact the community to determine whether more restrictive local or State regulations apply to the building or site in question. All applicable standards of the State or local building code must also be met for any building in a flood hazard area.

Guidance for Non-Engineered Foundation Openings

Each of the following four design criteria must be met for new and substantially improved A-zone buildings that have enclosed areas below the BFE with openings not designed and certified by a design professional:

1. There must be a minimum of two openings on different sides of each enclosed area. If a building has more than one enclosed area, each area must have openings on exterior walls to allow floodwater to directly enter.

2. The total area of all openings must be at least 1 square inch for each 1 square foot of enclosed area.

3. The bottom of each opening can be no more than 1 foot above the adjacent grade.

4. Any louvers, screens, or other opening covers must not block or impede the automatic flow of floodwaters into and out of the enclosed area.

Types of Buildings Affected

In all cases, any enclosed area below the BFE is subject to flood forces and must be equipped with exterior wall openings in accordance with the NFIP regulations, either at the time of initial construction or, if the building is being substantially improved, at the time of improvement. The only exception to this requirement is floodproofed non-residential buildings that are engineered and meet stringent watertight construction requirements. For further information on this topic, refer to Technical Bulletin 3, "Non-Residential Floodproofing — Requirements and Certification."

Buildings Elevated on Solid Foundation Walls

When a building is elevated on solid foundation walls, an enclosed area is often created below the lowest floor. All foundation enclosures below the BFE must have openings that meet NFIP criteria. Figure 1 shows an example of a properly placed foundation opening. As discussed previously, screens, louvers, or other covers that allow floodwaters to flow freely into the enclosed area may be placed over the openings to keep out vermin and weather.

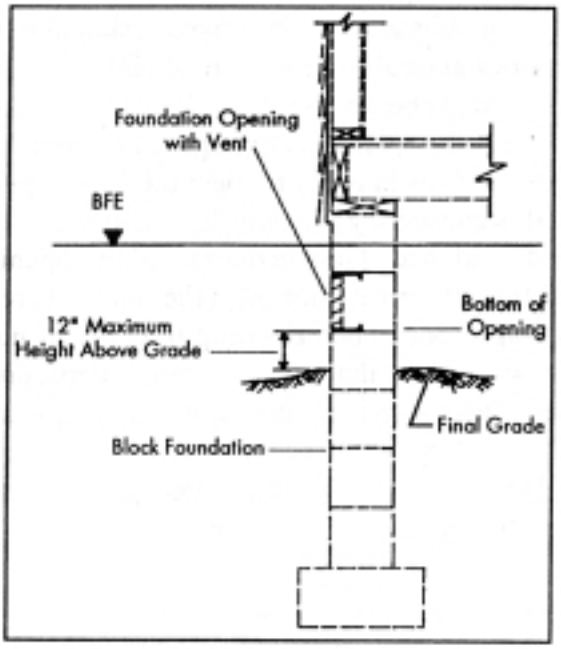


Figure 1. Opening for Solid Foundation Wall

Care must be taken when placing fill dirt around the outside of the foundation. The resulting enclosed area may be considered a basement under the NFIP. A basement is defined as any area of a building having a floor (finished or unfinished) that is subgrade (below grade) on all sides. The NFIP regulations do not permit a residential building in an SFHA to have a basement whose lowest floor (including basement) is below the BFE.

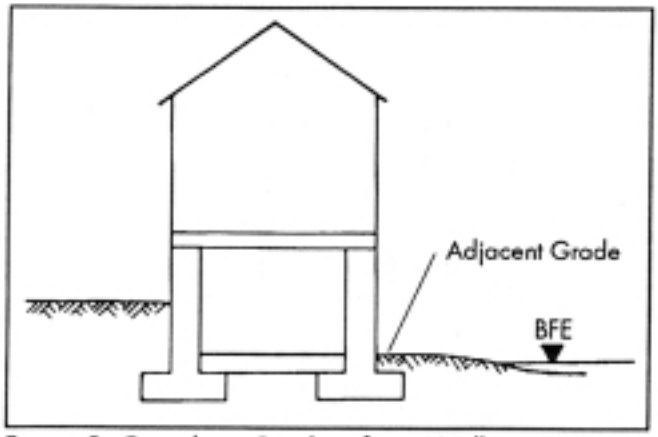


Figure 2. Compliant Grading for a Walkout Basement

To meet the NFIP requirements, fill placed around foundation walls must be graded so that the grade inside the enclosed area is equal to or higher than the adjacent grade outside the building on at least one side of the building (as illustrated in Figure 2). If the grade inside the foundation walls is above the BFE, openings are not required.

Buildings in Hazardous Velocity Areas

In coastal A zones, or in riverine A zones where flood velocities exceed 5 feet per second, fast-flowing floodwaters can exert considerable pressure on solid foundation walls. This hydrodynamic pressure, as described in the following section, may destroy a building's foundation. In such areas, foundations that allow floodwaters to flow freely beneath the building should be considered. Foundations such as piles, piers, or columns will provide the appropriate level of safety to a building located in a hazardous velocity area, if properly embedded and anchored. See the discussion of hydrodynamic pressure for design guidance.

Buildings in A-zone floodplains with velocity floodwaters may have breakaway walls constructed in areas below the BFE. Compliant foundation openings are required in breakaway walls in A zones.

Buildings with Attached Garages

Any new or substantially improved residential building constructed in an A zone must have its lowest floor at or above the BFE. Many of these buildings have structurally attached garages with floor slabs below the BFE. Because such a below-BFE attached garage is an enclosed area below the BFE, openings are required either in the exterior walls of the garage or in the garage doors themselves in order to meet the NFIP openings criteria (see Figure 3). Openings are required because they prevent flood damage to the garage and subsequently to the structurally attached residence. Garage doors without openings specifically designed to allow for the free flow of floodwaters do not meet the openings requirement. The human intervention necessary to open garage doors when flooding threatens is not an acceptable means of meeting the openings requirement. Gaps that may be present between the door segments and between the garage door and the garage door jamb do not guarantee the automatic entry and exit of floodwaters. Therefore, openings are required either in the exterior walls of the enclosed area or in the garage doors themselves. Openings in garage doors must either meet the non-engineered openings requirements or be certified by a design professional.

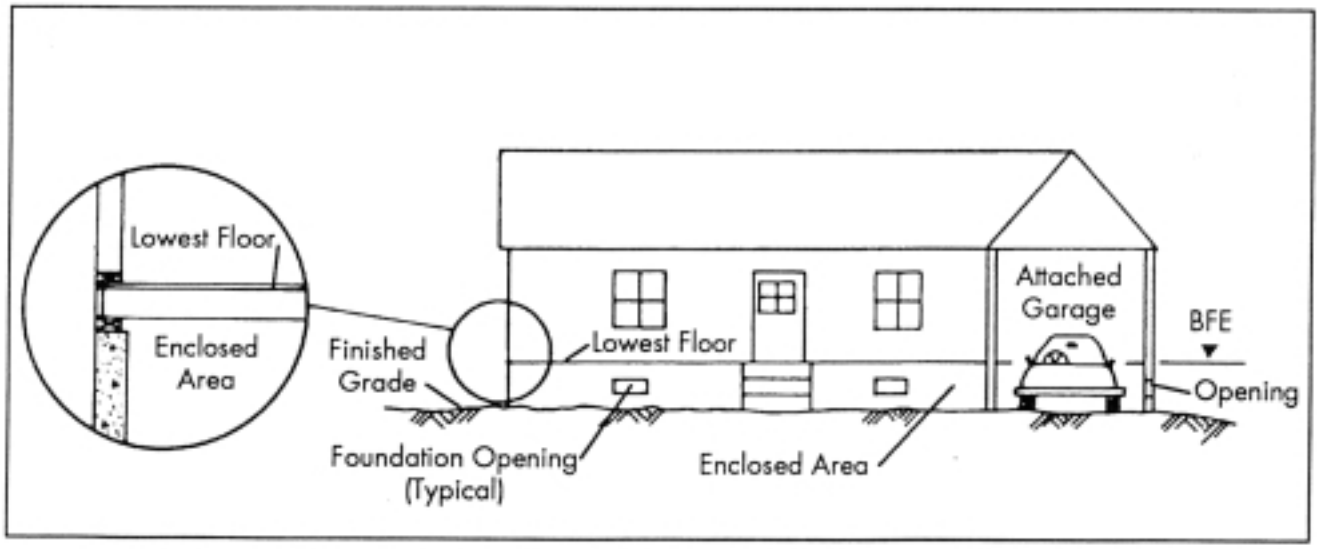


Figure 3. Compliant Residential Building Built on Solid Foundation Walls With Attached Garage

Hydrostatic pressure on an enclosed area above grade can be calculated by multiplying the specific weight of water (62.4 pounds per cubic foot) by the height of the water on the surface being analyzed. The application of the force generated by hydrostatic pressure is always perpendicular (normal) to the surface in question. In the case of a submerged object, this means that hydrostatic forces act in two ways. First, the force will act laterally (see Figure 5), which can result in collapse of walls or movement of the entire building off its foundation. Second, the force will act vertically (the vertical force is also known as buoyancy, see Figure 6), which can result in the building being lifted from its foundation or floor system.

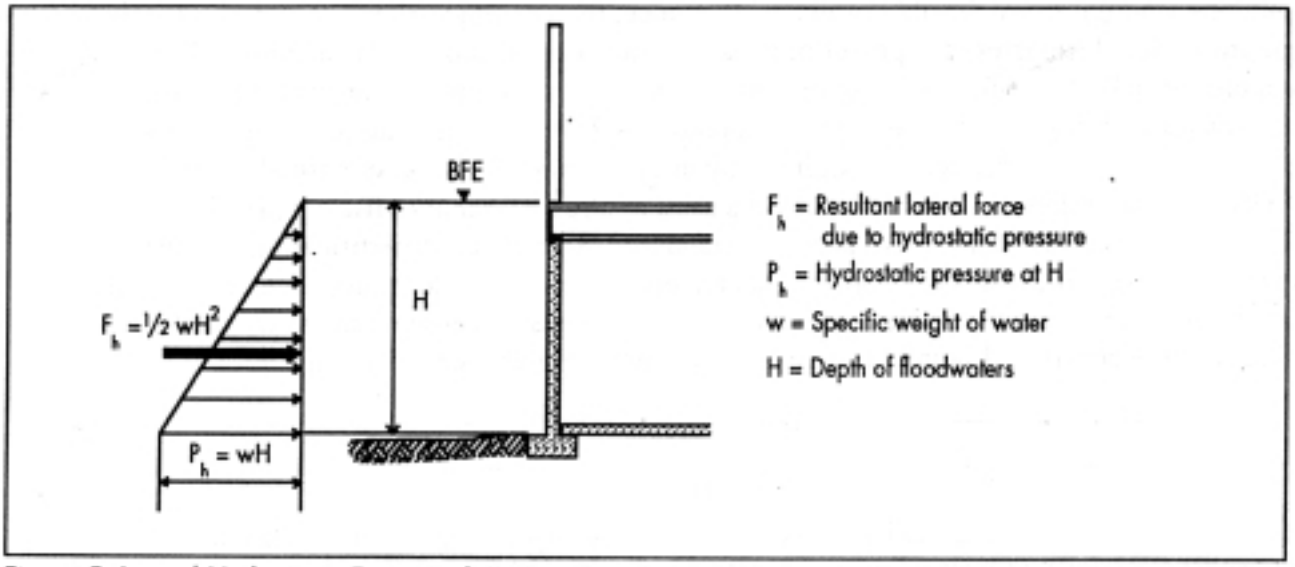


Figure 5. Lateral Hydrostatic Force and Pressure

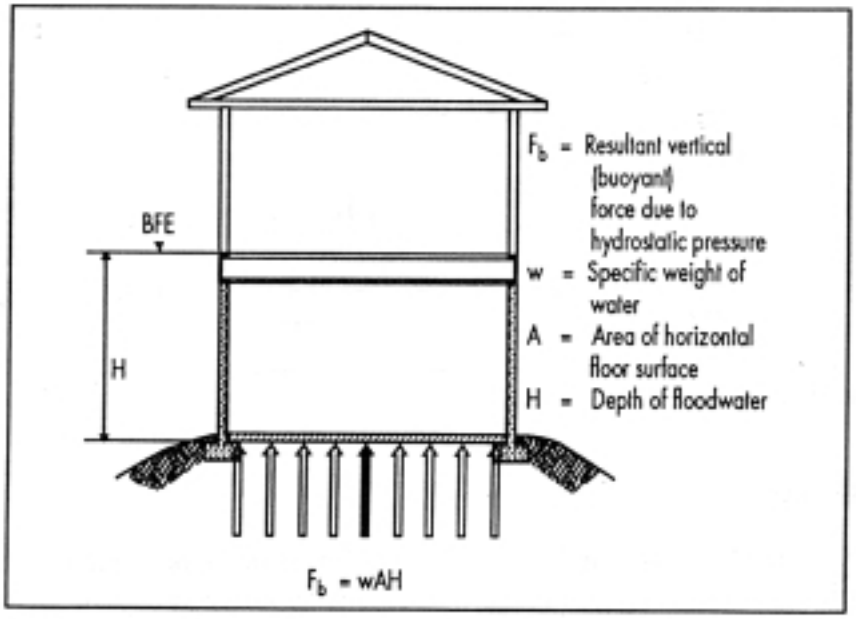


Figure 6. Buoyancy Force

Hydrostatic pressure on an enclosed area above grade can be calculated by multiplying the specific weight of water (62.4 pounds per cubic foot) by the height of the water on the surface being analyzed. The application of the force generated by hydrostatic pressure is always perpendicular (normal) to the surface in question. In the case of a submerged object, this means that hydrostatic forces act in two ways. First, the force will act laterally (see Figure 5), which can result in collapse of walls or movement of the entire building off its foundation. Second, the force will act vertically (the vertical force is also known as buoyancy, see Figure 6), which can result in the building being lifted from its foundation or floor system.

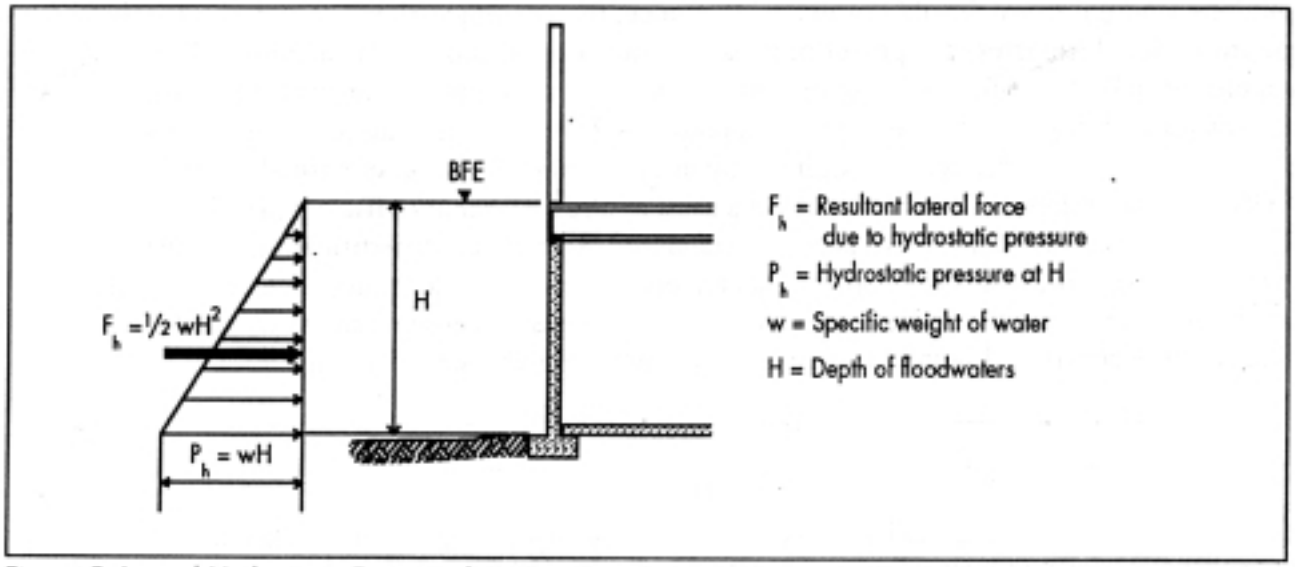


Figure 5. Lateral Hydrostatic Force and Pressure

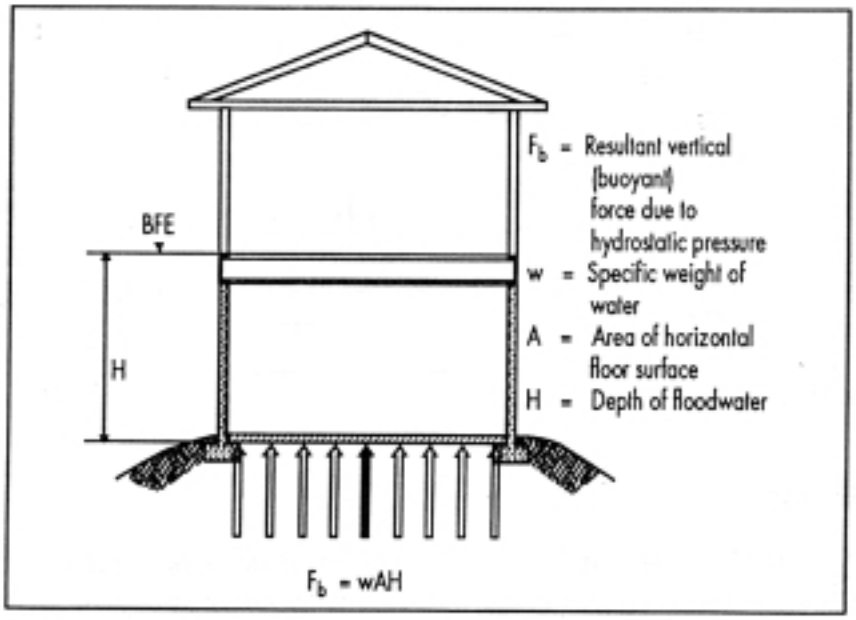


Figure 6. Buoyancy Force

To describe hydrostatic pressure in more technical terms:

The hydrostatic pressure, P_h, at a specific location on a structure is:

$P_h = wH$

where:	P_h	is the pressure in pounds per square foot
	w	is the specific weight of water, 62.4 pounds per cubic foot
	H	is the depth from the surface of the water to the location in question (generally from BFE to bottom of foundation wall)

The lateral force resulting from hydrostatic pressure is:

The resultant lateral (horizontal) force against the surface is:

$F_h = {}^1/_2 P_h H = {}^1/_2 wH^2$

where:	F_h	is the lateral force in pounds per linear foot of surface

Describing the hydrostatic vertical force (buoyancy) in more technical terms:

The buoyant (vertical) hydrostatic force acting against a horizontal surface such as a floor slab is:

$F_b = wAH$

where:	F_b	is the total buoyant force in pounds
	w	is the specific weight of water, 62.4 pounds per cubic foot
	A	is the area of the horizontal surface in square feet
	H	is the depth of the building below the flood level

As shown in the following table, hydrostatic pressure, whether it affects a building laterally or vertically, increases rapidly as floodwater depths increase:

Height, H (in feet)	1	2	3	4	5	6	7	8
Pressure, P_h (in pounds per square foot)	62	125	187	250	312	374	437	499

Hydrodynamic pressure is exerted on all vertical surfaces of obstructions, such as building foundations, by the impact of velocity water and debris. Depending upon site-specific flood characteristics and the strength of the foundation, hydrodynamic pressure can overload and destroy a building's foundation. The openings criteria are intended to equalize hydrostatic pressure and are not intended to minimize hydrodynamic pressure on the foundation. Hydrodynamic pressure must be considered in the design of any foundation system where velocity waters or the potential for debris flow exists. If flood velocities are excessive (greater than 5 feet per second), foundation systems other than solid foundation walls should be considered, so that obstructions to damaging flood flows are minimized. Safe foundations in such locations include pile, post, column, and pier foundations. These types of foundation systems are appropriate for A zones in coastal environs subject to waves and velocity floodwaters, as well as in riverine floodplains subject to velocity floodwaters (velocities greater than 5 feet per second) and areas subject to debris flows and ice floes. In areas with high-velocity floodwaters, it is advisable to construct any enclosures below the BFE using the breakaway wall specifications described in FEMA's "Coastal Construction Manual." As stated previously, breakaway walls in A zones must have openings compliant with NFIP regulatory requirements so that hydrostatic pressures are equalized during low-level flood events.

Design Criteria for Engineered Openings

Engineered openings that allow floodwaters into an enclosure for the purpose of equalizing hydrostatic pressures shall be designed using the following criteria:

- The difference between the exterior and interior floodwater levels should not exceed 1 foot at any time during the flood event. Greater differences can result in excessive hydrostatic pressures and structural damage to the enclosure walls.
- The arrangement of the openings must be capable of equalizing the hydrostatic pressures associated with the "worst-case" rate of rise of floodwaters. Historical flooding information should be used to determine rate of rise. A rate of rise of 5 feet per hour was assumed in the development of the NFIP non-engineered openings design criteria.
- Because of the large amount of debris associated with flooding and because openings will often be equipped with some form of vermin screen to meet applicable building codes, there is a high probability that openings may be obstructed during a flood. For this reason, a substantial safety factor is needed. Standard engineering practice is to use a safety factor of 5 in similar life/safety situations involving potential structural failure; therefore, a safety factor

of 5 was incorporated into the calculations that follow. Openings on the sides of the building facing the primary direction of velocity flow will add an additional safety factor; however, such openings will tend to be blocked with debris sooner than other openings.

- At least two openings must be included to provide for a safety factor against debris blockage. This safety factor is enhanced when openings are located on at least two different sides of the enclosed area. This will allow for more even filling and emptying of the enclosed area and will also reduce the risk of debris being forced against an opening and blocking it.

The first step in determining the total net area required for openings is to calculate the flow rate per square foot of enclosed area, which is based on the rate of rise of the floodwaters. The assumed worst-case rate of rise is 5 feet per hour per square foot of area, or about 0.1 foot per minute. To convert this to gallons per minute per square foot of enclosed area, multiply by a conversion factor of 7.5 gallons per cubic foot. The needed flow rate into the enclosure per square foot of area is then (0.1 foot per minute) times (7.5 gallons per cubic foot), or 0.8 gallon per minute per square foot of enclosed area. The second step is outlined below.

To determine the total net area of the openings, A, needed to permit the above flow rate, the formula is:

$$Q = 38.0cA(p)^{.5}$$

Solving for area A and multiplying by a factor of safety:

$$A = \frac{Q}{38.0\ cp^{.5}}\ (FS)$$

where:	A	is the net area of openings required, in square inches
	Q	is the flow rate per square foot, which is 0.8 gallon per minute
	c	is the coefficient of discharge, which is assumed to be 0.2
	p	is the pressure, which for one square foot of differential is 62.4 pounds per square foot, or 0.4 pound per square inch
	FS	is the factor of safety, which is 5

Therefore:

$$A = \frac{0.8}{38.0 \times 0.2 \times 0.6}\ (5)$$

= about 1.0 square inch of opening per square foot of enclosed area.

The NFIP

The NFIP was created by Congress in 1968 to provide federally backed flood insurance coverage, because it was generally unavailable from private insurance companies. The NFIP is also intended to reduce future flood losses by identifying floodprone areas and ensuring that new

development in these areas is adequately protected from flood damage. The NFIP is based on a mutual agreement between the federal government and communities that have been identified as floodprone. FEMA, through the Federal Insurance Administration (FIA), makes flood insurance available to community residents provided that the participating community adopts and enforces adequate floodplain management regulations that meet the minimum NFIP requirements. The NFIP encourages communities to adopt floodplain management ordinances that exceed the minimum NFIP criteria. Included in the NFIP requirements, found under Title 44 of the U.S. Code of Federal Regulations, are minimum building design and construction standards for buildings located in SFHAs. Through their floodplain management ordinances, communities adopt the NFIP design performance standards for new and substantially improved buildings located in floodprone areas identified on FIA's Flood Insurance Rate Maps.

Technical Bulletins

This is one of a series of Technical Bulletins FEMA has produced to provide guidance concerning the building performance standards of the NFIP. These standards are contained in Title 44 of the U.S. Code of Federal Regulations at Section 60.3. The bulletins are intended for use primarily by State and local officials responsible for interpreting and enforcing NFIP regulations and by members of the development community, such as design professionals and builders. New bulletins, as well as updates of existing bulletins, are issued periodically, as necessary. The bulletins do not create regulations; rather they provide specific guidance for complying with the minimum requirements of existing NFIP regulations. Users of the Technical Bulletins who need additional guidance concerning NFIP regulatory requirements should contact the Natural Hazards Branch of the appropriate FEMA regional office. The "User's Guide to Technical Bulletins" lists the bulletins issued to date and provides a key word/subject index for the entire series.

Ordering Information

Copies of the Technical Bulletins can be obtained from the appropriate FEMA regional office. Technical Bulletins can also be ordered from the FEMA publications warehouse. Use of FEMA Form 60-8 will result in a more timely delivery from the warehouse — the form can be obtained from FEMA regional offices and your state's Office of Emergency Management. Send publication requests to FEMA Publications, P.O. Box 70274, Washington, D.C. 20024.

Further Information

The following publications provide further information concerning openings in foundation walls:

1. "Answers to Questions About Substantially Damaged Buildings," FEMA, May 1991, FEMA-213.
2. "Coastal Construction Manual," FEMA, February 1986, FEMA-55.
3. "Colorado Floodproofing Manual," Colorado Department of Natural Resources, Water Conservation Board, October 1983.
4. "Design Manual for Retrofitting Flood-Prone Residential Structures," FEMA, September 1986, FEMA-114.

5. "Elevated Residential Structures," FEMA, May 1986, FEMA-54.

6. "Elevating Flood-Prone Buildings: A Contractor's Guide," Illinois Department of Transportation, Division of Water Resources, 1985.

7. "Flood Proofing Regulations," U.S. Army Corps of Engineers, March 1992, EP 1165-2-314.

8. "Flood Proofing Systems and Techniques," U.S. Army Corps of Engineers, December 1984.

9. "Foundation Analysis and Design," Second Edition, Joseph E.Bowles, McGraw-Hill Book Co., New York.

Glossary

Base flood — The flood that has a 1-percent probability of being equaled or exceeded in any given year (also referred to as the 100-year flood).

Base Flood Elevation (BFE) — The height of the base flood, usually in feet, in relation to the National Geodetic Vertical Datum of 1929 or other datum as specified.

Basement — Any area of a building having its floor subgrade (below ground level) on all sides.

Coastal High Hazard Area — An area of special flood hazard extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high-velocity wave action from storms or seismic sources.

Federal Emergency Management Agency (FEMA) — The independent federal agency that, in addition to carrying out other activities, oversees the administration of the National Flood Insurance Program.

Federal Insurance Administration (FIA) — The component of FEMA directly responsible for administering the National Flood Insurance Program.

Flood Insurance Rate Map (FIRM) — The insurance and floodplain management map issued by FEMA that identifies, on the basis of detailed or approximate analyses, areas of 100-year flood hazard in a community.

Floodprone area — Any land area susceptible to being inundated by floodwater from any source.

Lowest floor — The lowest floor of the lowest enclosed area of a building, including a basement. Any NFIP-compliant unfinished or flood-resistant enclosure useable solely for parking of vehicles, building access, or storage (in an area other than a basement) is not considered a building's lowest floor.

Special Flood Hazard Area (SFHA) — Area delineated on a Flood Insurance Rate Map as being subject to inundation by the base flood and designated as Zone A, AE, A1-A30, AR, A0, AH, V, VE, or V1-V30.

Substantial damage — Damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred.

Substantial improvement — Any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the "start of construction" of the improvement. This term includes structures that have incurred "substantial damage," regardless of the actual repair work performed.

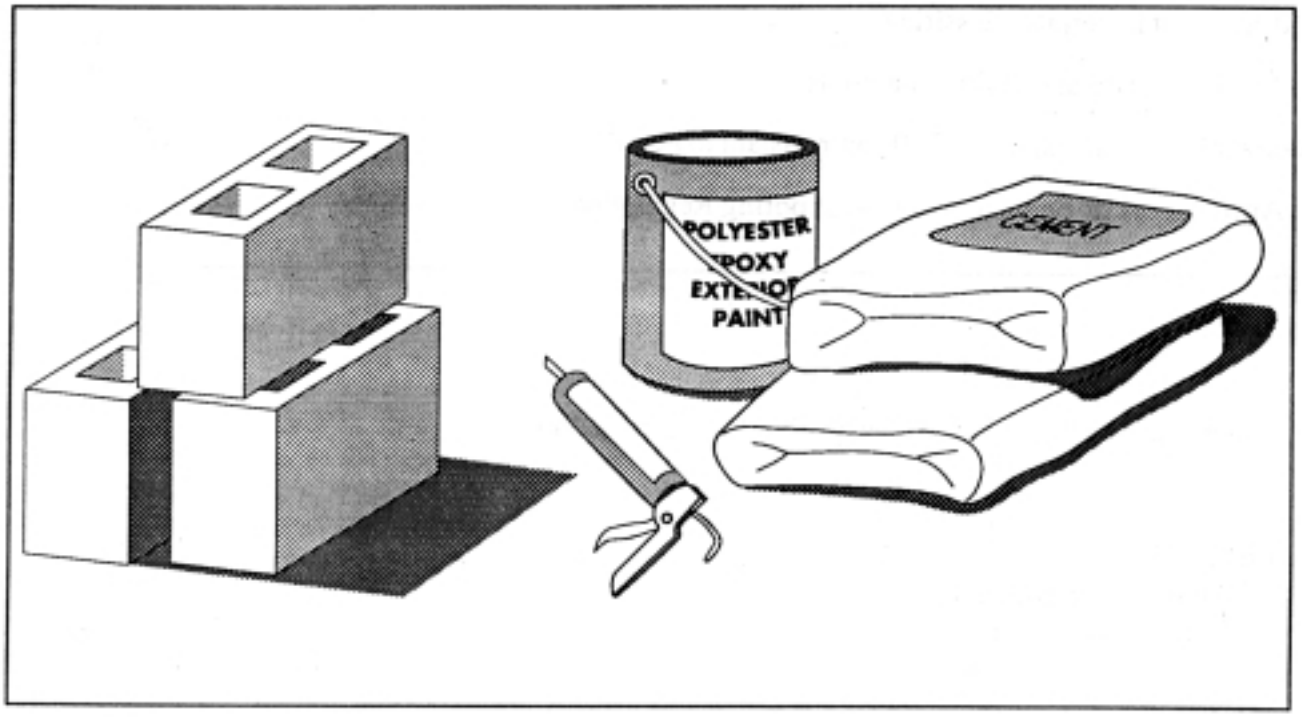
Technical Bulletin 2-93

Flood-Resistant Materials Requirements

for Buildings Located in Special Flood Hazard Areas

in accordance with the

National Flood Insurance Program



FEDERAL EMERGENCY MANAGEMENT AGENCY
FEDERAL INSURANCE ADMINISTRATION

FIA-TB-2
4/93

Key Word/Subject Index:

This index allows the user to quickly locate key words and subjects in this Technical Bulletin. The Technical Bulletin User's Guide (printed separately) provides references to key words and subjects throughout the Technical Bulletins. For definitions of selected terms, refer to the Glossary at the end of this bulletin.

Any comments on the Technical Bulletins should be directed to:

FEMA/FIA
Office of Loss Reduction
Technical Standards Division
500 C St., SW, Room 417
Washington, D.C. 20472

Technical Bulletin 2-93 replaces Technical Bulletin 88-2 (draft) "Flood-Resistant Materials."

Graphic design based on the Japanese print *The Great Wave Off Kanagawa*, by Katsushika Hokusai (1760-1849), Asiatic collection, Museum of Fine Arts, Boston.

TECHNICAL BULLETIN 2-93

Flood-Resistant Materials Requirements for Buildings Located In Special Flood Hazard Areas in accordance with the National Flood Insurance Program

Introduction

The requirement to use construction and finishing materials that are resistant to flood damage in all new and substantially improved buildings in identified Special Flood Hazard Areas (SFHAs) is an important part of the National Flood Insurance Program's (NFIP's) flood-damage-resistant design and construction standards. A residential building's lowest floor is required to be elevated to or above the base flood elevation (BFE). All construction below the lowest floor is susceptible to flooding and must consist of flood-resistant materials. Uses of enclosed areas below the lowest floor in a residential building are limited to parking, building access, and limited storage—areas that can withstand inundation by floodwater without sustaining significant structural damage.

The purpose of this Technical Bulletin is to provide data and guidance on what constitute "materials resistant to flood damage" and how and when these materials must be used to improve a building's ability to withstand flooding.

NFIP Regulations

Section 60.3(a)(3) of the NFIP regulations requires that the community:

> ***"Review all permit applications to determine whether proposed building sites will be reasonably safe from flooding. If a proposed building site is in a floodprone area, all new construction and substantial improvements shall...(ii) be constructed with materials resistant to flood damage..."***

It should be noted that Technical Bulletins provide guidance on the minimum requirements of the NFIP regulations. Community or State requirements that exceed those of the NFIP take precedence. Design professionals should contact the community to determine whether more restrictive local or State regulations apply to the building or site in question. All applicable standards of the State or local building code must also be met for any building in a flood hazard area.

Required Use of Flood-Resistant Materials

Flood-Resistant Material

"Flood-resistant material" is defined as any building material capable of withstanding direct and prolonged contact with floodwaters without sustaining significant damage. The term "prolonged contact" means at least 72 hours, and the term "significant damage" means any damage requiring more than low-cost cosmetic repair (such as painting).

As stated previously, **all structural and non-structural building materials at or below the BFE must be flood resistant**. This requirement applies regardless of the expected or historic flood duration. For example, buildings in coastal areas that experience relatively short-duration flooding (generally, flooding with a duration of less than 24 hours) must be constructed with flood-resistant materials below the BFE. As noted in the tables within this bulletin, **only Class 4 and Class 5 materials are acceptable for areas below the BFE in floodprone buildings**.

In some instances, Class 1, 2, and 3 materials may be permitted below the BFE, when specifically required to meet local building code provisions concerning life-safety issues. In below-BFE applications, materials that meet life-safety code requirements and have maximum resistance to damage from flood inundation should be used. This applies to the flood-resistant requirements only. In Zones V, VE, and V1-V30, the installation of such materials may create an obstruction. Because obstructions in V zones could result in structural failure of the building, they represent a life-safety issue and shall therefore take precedence over local building codes. Refer to Technical Bulletin 5, "Free of Obstruction Requirements," for further information.

Lowest Floor

Under the NFIP, the term "lowest floor" is used to define the lowest level of a building that must be located at or above the BFE as required under Sections 60.3(c)(2) and (3) of the NFIP regulations. The floodplain management regulations, under Section 60.3(c)(5), limit the use of all areas below the lowest floor to parking of vehicles, storage, and building access. These reasonable uses below the BFE are permitted because the amount of damage caused by flooding to these areas can easily be kept to a minimum if design and construction requirements contained in the NFIP regulations are met. Failure to meet the requirements can increase the building's damage potential and result in the application of higher flood insurance premiums. The requirement to use flood-resistant materials means that all interior wall, floor, and ceiling materials located below the BFE be unfinished and resistant to flood damage. This is meant to exclude the use of materials and finishes normally associated with living areas constructed above the BFE.

Flood Insurance Implication

An NFIP flood insurance requirement regarding the use of materials in areas below the BFE must also be considered. Flood insurance will not pay a claim for finishing materials (such as clay floor tiles) located in basements or in enclosed areas below the lowest floor of an elevated building, even if such materials are considered to be flood resistant. The NFIP defines finishing materials as anything beyond basic wall construction.

Flood-Resistant Classification of Materials

The information in this Technical Bulletin is based primarily on the U.S. Army Corps of Engineers (COE) 1992 "Flood Proofing Regulations." The following table (Table 1) classifies building materials according to their ability to resist flood damage.

Table 1 Flood-Resistant Classification of Materials

NFIP	Class	Class Description
ACCEPTABLE	5	Highly resistant to floodwater damage. Materials within this class are permitted for partially enclosed or outside uses with essentially unmitigated flood exposure.
	4	Resistant to floodwater damage. Materials within this class may be exposed to and/or submerged in floodwaters in interior spaces and do not require special waterproofing protection.
UNACCEPTABLE	3	Resistant to clean water damage. Materials within this class may be submerged in clean water during periods of intentional flooding.
	2	Not resistant to water damage. Materials within this class require essentially dry spaces that may be subject to water vapor and slight seepage.
	1	Not resistant to water damage. Materials within this class require conditions of dryness.

Source: COE 1992 "Floodproofing Regulations"

Flooring Materials

Table 2 lists flooring materials commonly used in construction that fall within the five classes described in Table 1. Not all available construction and finishing materials are listed. For products not listed herein, manufacturers' literature should be reviewed for recommended uses. Such recommendations must be complied with fully. All masonry and wood products used in floodprone buildings must comply with the applicable materials standards of the nationally recognized standards organizations, such as the American Society for Testing and Materials (ASTM), the American Concrete Institute (ACI), and the American Wood Products Association (AWPA).

Basis for Classification of Flooring Materials

The classification of flooring materials is based on their vulnerability to damage from inundation by floodwaters. Class 1, 2, and 3 flooring materials are not acceptable for below-BFE applications for one or more of the following reasons:

- Normal suspended-floor adhesives specified for above-grade use are water soluble or are not resistant to alkali or acid in water, including ground seepage and vapor.
- Flooring materials contain wood and wood products.
- Flooring materials are not resistant to alkali or acid in water.
- Sheet-type floor coverings (linoleum, rubber, and vinyl) restrict evaporation from below.
- Flooring materials are impervious but dimensionally unstable.

Table 2 Flooring Materials Classifications for Flood Resistance					
Types of Flooring Materials	Classes of Flooring				
	Acceptable		Unacceptable		
	5	4	3	2	1
Asphalt Tile[1]					●
With asphaltic adhesives			●		
Carpeting (glued down type)					●
Cement/bituminous, formed-in-place		●			
Cement/latex, formed-in-place		●			
Ceramic tile[1]					●
With acid-and alkali-resistant grout			●		
Chipboard					●
Clay tile	●				
Concrete, precast or in-situ	●				
Concrete tile	●				
Cork					●
Enamel felt-base floor coverings					●
Epoxy, formed-in-place	●				
Linoleum					●
Magnesite (magnesium oxychloride)					●
Mastic felt-base floor covering					●
Mastic flooring, formed-in-place	●				
Polyurethane, formed-in-place	●				
PVA emulsion cement					●
Rubber sheets[1]					●
With chemical-set adhesives[2,3]	●				
Rubber tile[1]					●
With chemical-set adhesives[3]		●			
Silicone floor, formed-in-place	●				

Table 2 Flooring Materials Classifications for Flood Resistance

Types of Flooring Materials	Classes of Flooring				
	Acceptable		Unacceptable		
	5	4	3	2	1
Terrazo		●			
Vinyl sheets (homogeneous)[1]					●
With chemical-set adhesives[2,3]	●				
Vinyl tile (homogeneous)[1]					●
With chemical-set adhesives[3]		●			
Vinyl tile or sheets (coated on cork or wood product backings)					●
Vinyl-asbestos tile (semi-flexible vinyl)[1]					●
With asphaltic adhesives		●			
Wood flooring or underlayments					●
Wood composition blocks, laid in cement mortar				●	
Wood composition blocks, dipped and laid in hot pitch or bitumen				●	
Pressure-treated lumber, .40 CCA[4]	●				
Naturally decay-resistant lumber[4,5]	●				

Notes:
1 Using normally specified suspended flooring (i.e., above-grade) adhesives, including sulfite liquor (lignin or "linoleum paste"), rubber/asphaltic dispersions, or "alcohol" type resinous adhesives (culmar, oleoresin)

2 Not permitted as Class 2 flooring

3 E.g., epoxy-polyamide adhesives or latex-hydraulic cement

4 Not in the COE list; added by FEMA

5 Refer to local building code for guidance

Wall and Ceiling Materials

Table 3 lists wall and ceiling materials commonly used in construction that fall within the five classes described in Table 1. Not all available construction and finishing materials are listed. For products not listed herein, manufacturers' literature should be reviewed for recommended uses. Such recommendations must be complied with fully. All masonry and wood products used in floodprone buildings must comply with the applicable materials standards of the nationally recognized standards organizations, such as the American Society for Testing and Materials (ASTM), the American Concrete Institute (ACI), and the American Wood Products Association (AWPA).

Basis for Classification of Wall and Ceiling Materials

The classification of wall and ceiling materials is based on their vulnerability to damage from inundation by floodwaters. Class 1, 2, and 3 wall and ceiling materials are not acceptable for below-BFE applications for one or more of the following reasons:

- Normal adhesives specified for above-grade use are water soluble or are not resistant to alkali or acid in water, including ground seepage and vapor.
- Wall and ceiling material contains wood, wood products, gypsum products, or other material that dissolves or deteriorates, loses structural integrity, or is adversely affected by water.
- Wall or ceiling material is not resistant to alkali or acid in water.
- Wall or ceiling material is impervious but is dimensionally unstable.
- Wall or ceiling materials absorb or retain water excessively after submergence.

Table 3 Walls and Ceiling Materials Classifications for Flood Resistance					
Types of Wall and Ceiling Materials	Classes of Walls and Ceilings				
	Acceptable		Unacceptable		
	5	4	3	2	1
Asbestos-cement board (and cement board[1])	●				
Brick, face or glazed	●				
Common				●	
Cabinets, built-in					
Wood				●	
Metal	●				
Cast stone (in waterproof mortar)	●				
Chalkboards					
Slate, porcelain glass, nucite glass	●				
Cement-asbestos				●	
Composition, painted				●	
Chipboard					●
Exterior sheathing grade				●	
Clay tile					
Structural glazed	●				
Ceramic veneer, ceramic wall tile-mortar set		●			
Ceramic veneer, organic adhesives				●	
Concrete	●				
Concrete block	●				
Corkboard				●	
Doors					
Wood hollow				●	
Wood, lightweight panel construction				●	
Wood, solid				●	
Metal, hollow	●				
Metal, Kalamein				●	

Table 3 Walls and Ceiling Materials Classifications for Flood Resistance

Types of Wall and Ceiling Materials	Classes of Walls and Ceilings				
	Acceptable		Unacceptable;		
	5	4	3	2	1
Fiberboard panels, vegetable types					
Sheathing grade (asphalt coated or impregnated)				●	
Otherwise					●
Gypsum products					
Gypsum board (including greenboard[1])				●	
Keene's cement of plaster				●	
Plaster, otherwise, including acoustical				●	
Sheathing panels, exterior grade				●	
Glass (sheets, colored tiles, panels)		●			
Glass blocks	●				
Hardboard					
Tempered, enamel or plastic coated				●	
All other types				●	
Insulation					
Foam or closed-cell types		●			
Batt or blanket types					●
All other types				●	
Metals, non-ferrous (aluminum, copper, or zinc tiles)			●		
Metals, Ferrous	●				
Mineral fiberboard					●
Plastic wall tile (polystyrene, urea formaldehyde, etc.)					
Set in waterproof adhesives, pointed with waterproof grout			●		
Set in water-soluble adhesives				●	

Table 3 Walls and Ceiling Materials Classifications for Flood Resistance

Types of Wall and Ceiling Materials	Classes of Walls and Ceilings				
	Acceptable		Unacceptable		
	5	4	3	2	1
Paint					
Polyester-epoxy and other waterproof types		●			
All other types					●
Paperboard					●
Partitions, folding					
Wood, pressure treated, .40 CCA minimum 1 (if not treated, then material is Class 2)	●				
Metal		●			
Fabric-covered					●
Partitions, stationary					
Wood, pressure treated, .40 CCA minimum 1 (if not treated, then material is Class 2)	●				
Metal	●				
Glass, unreinforced		●			
Glass, reinforced		●			
Gypsum, solid or block					●
Rubber, moldings and trim with epoxy polyamide adhesive or latex-hydraulic cement		●			
All other applications					●
Steel, (panels, trim, tile) with waterproof applications	●				
With non-waterproof adhesive				●	
Stone, natural solid or veneer, waterproof grout	●				
Stone, artificial non-absorbent solid or veneer, waterproof grout	●				
All other applications				●	

Table 3 Walls and Ceiling Materials Classifications for Flood Resistance

Types of Wall and Ceiling Materials	Classes of Walls and Ceilings				
	Acceptable		unacceptable		
	5	4	3	2	1
Strawboard					
Exterior grade (asphalt-impregnated kraft paper)				•	
All other types				•	
Wall covering					
Paper, burlap, cloth types					•
Wood					
Solid, standard				•	
Solid, naturally decay-resistant[1,2]	•				
Solid pressure treated, .40 CCA minimum[1]	•				
Plywood					
Marine Grade[1]	•				
Pressure treated, .40 CCA minimum[1]	•				
Exterior grade				•	
Otherwise					•

Note: 1 Not on the COE list; added by FEMA

2 Refer to local building code for guidance

Construction Examples

Flood-Resistant Materials in Buildings in Zones A, AE, A1-A30, AR, AO, and AH

Figure 1 illustrates a building elevated on solid foundation walls, over a crawlspace. The NFIP regulations require that the lowest floor be at or above the BFE. The construction method illustrated in Figure 1 meets this requirement. Note, however, that the flooring materials and supporting wood members are at or below the BFE. Therefore, in Figure 1, all materials supporting the lowest floor, including the flooring itself, must be made of flood-resistant materials.

To maximize the use of the area below the lowest floor, it is a common floodplain construction technique to elevate a building a full story (approximately 8 feet), even though the BFE may only be 4 or 5 feet above grade. In such cases, while the NFIP regulations require that Class 4 or 5 building materials be used below the BFE, FEMA strongly recommends that Class 4 or Class 5 materials also be used for the construction of the remainder of the building below the lowest floor. Flood damage from a greater-than-design flood event will thereby be reduced in the lower area.

Flood-Resistant Materials in Buildings in Zones V, VE, and V1-V30

All structural and non-structural materials installed below the BFE must be flood resistant . The NFIP regulations require that the bottom of the lowest horizontal structural member of the lowest floor (usually the floor beam or girder) of a building in Zone V, VE, or Vl-V30 be at or above the BFE. Therefore, all materials below the floor beam(s) must be flood resistant. This includes but is not limited to breakaway wall materials and open latticework. Breakaway walls will remain in place during low-level floods and must be flood resistant, so that they will not deteriorate over time after being soaked by floodwaters. Figure 2, on the next page, illustrates this requirement.

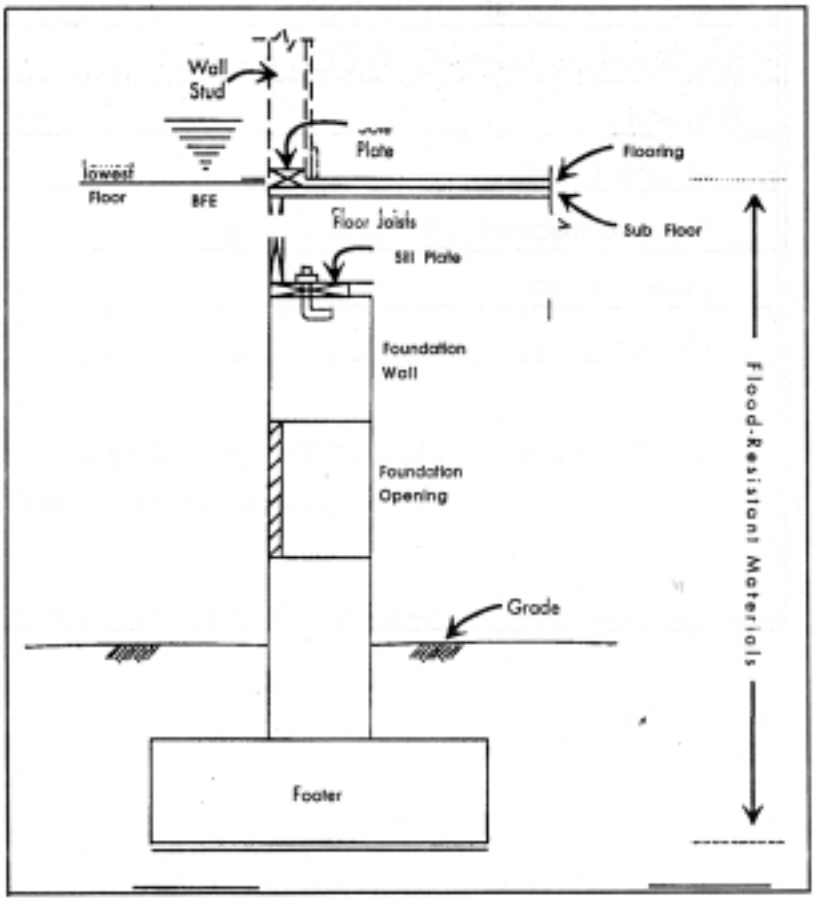


Figure 1. Building Elevated on Solid Foundation Walls Meeting the Minimum NFIP Requirements for Zones A, AE, A1-A30, AR, AO, and AH

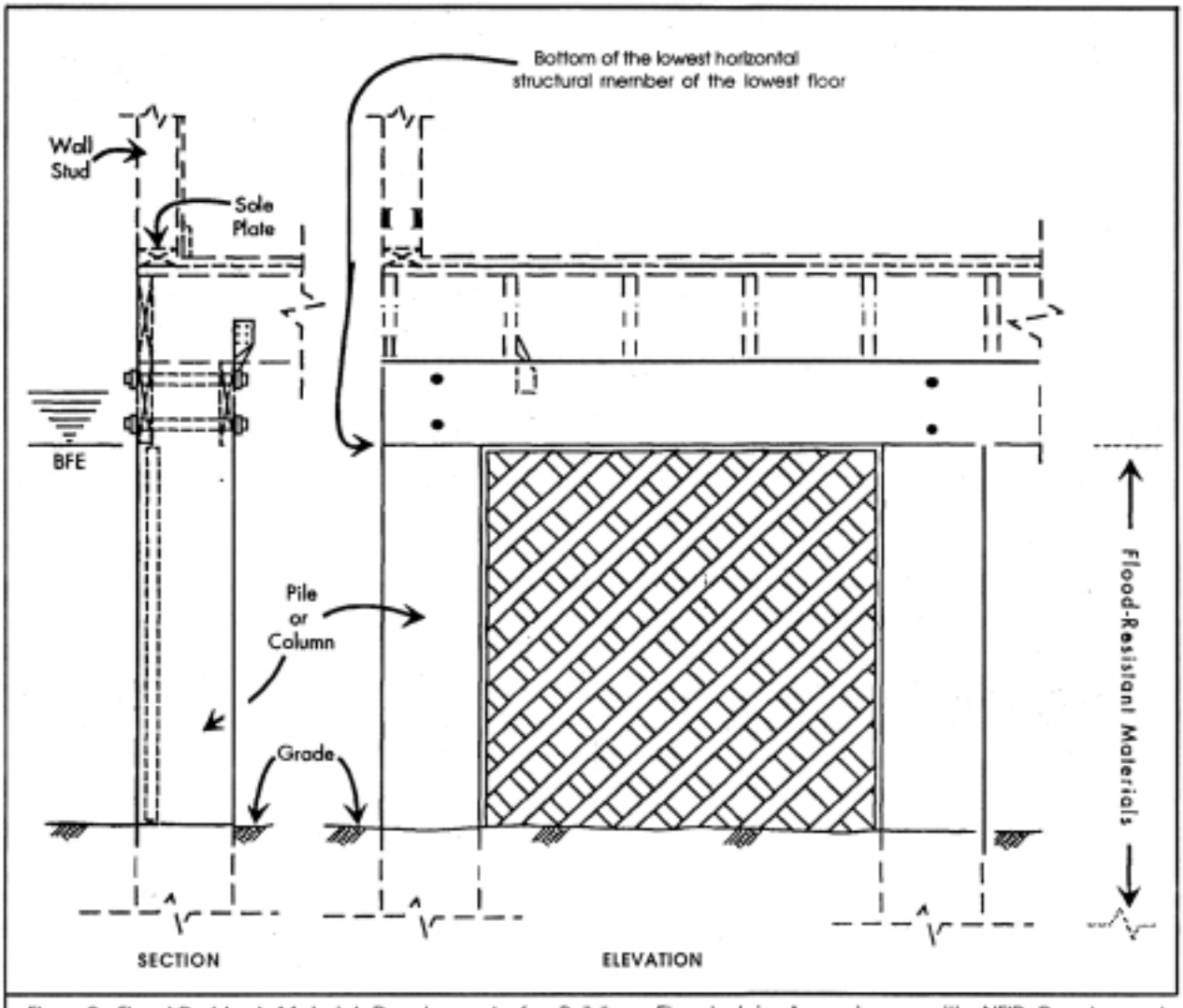


Figure2. Flood-Resistant Material Requirements for Buildings Elevated in Accordance with NFIP Requirements for Zones V, VE, and V1 -V30

Accessory Buildings

Some communities permit the construction of low-cost, small detached accessory buildings (e.g., garages, storage sheds) with a lowest floor elevation below the BFE (Technical Bulletin 5, "Free-of-Obstruction Requirements," provides definitions of "low-cost" and "small"). The below-BFE portions of such buildings must be constructed of flood-resistant materials so that flood damage will be minimized. Additional construction requirements for these buildings, such as the need to anchor the building to resist flotation. collapse, and lateral movement, also must be met before the building is permitted and built. For additional information about these requirements, contact the community that has permitting jurisdiction.

Wet Floodproofing

Wet floodproofing is designing a building to allow floodwaters to enter in order to equalize hydrostatic forces. The NFIP does not allow wet floodproofing in lieu of meeting the lowest

floor elevation requirements. However, in situations where the NFIP regulations do not apply, such as voluntary floodproofing of an existing (Pre-FIRM) building not in association with substantial improvements, the use of flood-resistant materials is advisable. Using flood-resistant materials will make cleanup and repair following a flood much easier and less costly than if the floodprone areas are constructed of non-flood-resistant materials.

The NFIP

The NFIP was created by Congress in 1968 to provide federally backed flood insurance coverage, because flood insurance was generally unavailable from private insurance companies. The NFIP is also intended to reduce future flood losses by identifying floodprone areas and ensuring that new development in these areas is adequately protected from flood damage. The NFIP is based on an agreement between the federal government and participating communities that have been identified as floodprone. FEMA, through the Federal Insurance Administration (FIA), makes flood insurance available to the residents of a participating community provided that the community adopts and enforces adequate floodplain management regulations that meet the minimum NFIP requirements. The NFIP encourages communities to adopt floodplain management ordinances that exceed the minimum NFIP criteria. Included in the NFIP requirements, found under Title 44 of the U.S. Code of the Federal Regulations, are minimum building design and construction standards for buildings located in SFHAs. Through their floodplain management ordinances, communities adopt the NFIP design performance standards for new and substantially improved buildings located in floodprone areas identified on FIA's FIRMs.

Technical Bulletins

This is one of a series of Technical Bulletins FEMA has produced to provide guidance concerning the building performance standards of the NFIP. These standards are contained in Title 44 of the U.S. Code of Federal Regulations at Section 60.3. The bulletins are intended for use primarily by State and local officials responsible for interpreting and enforcing NFIP regulations and by members of the development community, such as design professionals and builders. New bulletins, as well as updates of existing bulletins, are issued periodically, as necessary. The bulletins do not create regulations; rather they provide specific guidance for complying with the minimum requirements of existing NFIP regulations. Users of the Technical Bulletins who need additional guidance concerning NFIP regulatory requirements should contact the Natural Hazards Branch of the appropriate FEMA regional office. The "User's Guide to Technical Bulletins" lists the bulletins issued to date and provides a key word/subject index for the entire series.

Ordering Information

Copies of the Technical Bulletins can be obtained from the appropriate FEMA regional office. Technical Bulletins can also be ordered from the FEMA publications warehouse. Use of FEMA Form 60-8 will result in a more timely delivery from the warehouse — the form can be obtained from FEMA regional offices and your state's Office of Emergency Management. Send publication requests to FEMA Publications, P,O. Box 70274, Washington, D.C. 20024.

Further Information

The following publications provide further information concerning the use of flood-resistant materials:

1. "Answers to Questions About Substantially Damaged Buildings," FEMA, May 1991, FEMA-213.
2. "Floodproofing Non-Residential Structures," FEMA, May 1986, FEMA-102.
3. "Flood Proofing Regulations", Chapters 9 and 10, U.S. Army Corps of Engineers, March 1992, EP 1165-2-314.
4. "Flood Proofing Systems and Techniques," U.S. Army Corps of Engineers, December, 1984.
5. "Repairing Your Flooded Home," FEMA and the American Red Cross, August 1992, FEMA-234, ARC 4477.
6. "Technical Notes for Brick Construction,"Brick Institute of America, McLean, Virginia, n.d.

Glossary

Base flood — The flood that has a 1-percent probability of being equaled or exceeded in any given year (also referred to as the 100-year flood).

Base Flood Elevation (BFE) — The height of the base flood, usually in feet, in relation to the National Geodetic Vertical Datum of 1929 or other datum as specified.

Basement — Any area of a building having its floor subgrade (below ground level) on all sides.

Coastal High Hazard Area — An area of special flood hazard extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high-velocity wave action from storms or seismic sources.

Federal Emergency Management Agency (FEMA) — The independent federal agency that, in addition to carrying out other activities, oversees the administration of the National Flood Insurance Program.

Federal Insurance Administration (FIA) — The component of FEMA directly responsible for administering the National Flood Insurance Program.

Flood Insurance Rate Map (FIRM) — The insurance and floodplain management map issued by FEMA that identifies, on the basis of detailed or approximate analyses, areas of 100-year flood hazard in a community.

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Special Flood Hazard Area (SFHA) — Area delineated on a Flood Insurance Rate Map as being subject to inundation by the base flood and designated as Zone A, AE, A1-A30, AR, A0, AH, V, VE, or V1-V30.

Substantial damage — Damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred.

Substantial improvement — Any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the "start of construction" of the improvement. This term includes structures that have incurred "substantial damage," regardless of the actual repair work performed.

Protecting Utilities

FEMA
www.fema.gov

Purpose: To identify the special considerations that must be made when installing utility equipment in a coastal home.

Key Issues: Hazards, requirements, and recommendations

Special considerations must be made when installing utility systems in coastal homes. ***Proper placement and connection*** of utilities and mechanical equipment can ***significantly reduce the costs of damage caused by coastal storms*** and will ***enable homeowners to reoccupy their homes*** soon after electricity, sewer, and water are restored to a neighborhood.

Coastal Hazards That Damage Utility Equipment

- Standing or moving floodwaters
- Impact from floating debris in floodwaters
- Erosion and scour from floodwaters
- High winds
- Windborne missiles

Electrical lines and box dislocated by hurricane forces.

Common Utility Damage in Coastal Areas

Floodwaters cause corrosion and contamination, short-circuiting of electronic and electrical equipment, and other physical damage.

Fuel – Floodwaters can float and rupture tanks, corrode and short-circuit electronic components, and sever pipe connections. In extreme cases, damage to fuel systems can lead to fires.

Electrical – Floodwaters can corrode and short-circuit electrical system components, possibly leading to electrical shock. In velocity flow areas, electrical panels can be torn from their attachments by the force of breaking waves or the impact of floating debris.

Water/Sewage – Water wells can be exposed by erosion and scour caused by floodwaters with velocity flow. A sewage backup can occur even without the structure flooding.

Basic Protection Methods

The primary protection methods are ***elevation*** or ***component protection***.

Elevation of utilities and mechanical equipment is the preferred method of protection.

Elevation

Elevation refers to the location of a component and/or utility system above the Design Flood Elevation (DFE).

Component Protection

Component protection refers to the implementation of design techniques that protect a component or group of components from flood damage when they are located below the DFE.

NFIP Utility Protection Requirements

The NFIP regulations [Section 60.3(a)(3)] state that:

All new construction and substantial improvements shall be constructed with electrical, heating, ventilation, plumbing, and air conditioning equipment and other service facilities that are designed and/or located so as to prevent water from entering or accumulating within the components during conditions of flooding.

Utility Protection Recommendations

HVAC

- Install HVAC components (e.g., condensers, air handlers, ductwork, electrical components) above the DFE.
- Mount outdoor units on the leeward side of the building.
- Secure the unit so that it cannot move, vibrate, or be blown off its support.
- Protect the unit from damage by windborne debris.

Elevated air conditioning compressors.

Fuel

- Fuel tanks should be installed so as to prevent their loss or damage. This will require one of the following techniques: (1) elevation above the DFE and anchoring to prevent blowoff, (2) burial and anchoring to prevent exposure and flotation during erosion and flooding, (3) anchoring at ground level to prevent flotation during flooding and loss during scour and erosion. The first method (elevation) is preferred.
- Any anchoring, strapping, or other attachments must be designed and installed to resist the effects of corrosion and decay.

Electrical

- Limit switches, wiring, and receptacles below the DFE to those items required for life safety. Substitute motion detectors above the DFE for below-DFE switches whenever possible. Use only ground-fault-protected electrical outlets below the DFE.
- Locate electrical panels above the DFE.
- Use drip loops to minimize water entry at penetrations.
- Never attach electrical components to breakaway walls.

Water/Sewage

- Attach plumbing risers on the landward side of foundation elements.
- When possible, install plumbing runs inside joists for protection.
- Never attach plumbing runs to breakaway walls.

Additional Resources

American Society of Civil Engineers. *Flood Resistant Design and Construction* (SEI/ASCE 24-98). (http://www.asce.org)

FEMA. NFIP Technical Bulletin 5-93, *Free-Of-Obstruction Requirements for Buildings Located in Coastal High Hazard Areas*. (http://www.fema.gov/fima/techbul.shtm)

FEMA. *Protecting Building Utilities From Flood Damage*. FEMA 348. November 1999. (http://www.fema.gov/hazards/floods/lib06b.shtm)

Enclosures and Breakaway Walls

Purpose: To discuss requirements and recommendations for enclosures and breakaway walls below the Base Flood Elevation (BFE).

Key Issues

- Spaces below elevated buildings can be used only for building access, parking, and storage.
- Areas enclosed by solid walls below the BFE ("enclosures") are subject to strict regulation under the National Flood Insurance Program (NFIP). Note that some local jurisdictions enforce stricter regulations for enclosures.
- Non-breakaway enclosures are prohibited in V-zone buildings. Breakaway enclosures in V zones must meet specific requirements and must be certified by a registered design professional
- Enclosures (breakaway and non-breakaway) in A-zone buildings must be built with flood-resistant materials and equipped with flood openings that allow water levels inside and outside to equalize (see Fact Sheet No. 15).
- For V zones, enclosures below the elevated building will result in higher flood insurance premiums.
- Breakaway enclosure walls should be considered expendable, and the building owner will incur substantial costs when the walls are replaced.

Space Below the BFE — What Can it Be Used For?

NFIP regulations state that the area below an elevated building can be used only for ***building access, parking, and storage***. These areas must not be finished or used for recreational or habitable purposes. No mechanical, electrical, or plumbing equipment is to be installed below the BFE.

What Is an Enclosure?

An "***enclosure***" is formed when any space below the BFE is enclosed on all sides by walls or partitions. A V-zone building elevated on an open foundation (see Fact Sheet No. 11), without an enclosure or other obstructions below the BFE, is said to be free-of-obstructions, and enjoys favorable flood insurance premiums (a building is still classified free-of-obstructions if insect screening or open wood lattice is used to surround space below the BFE). See FEMA Technical Bulletin 5-93, *Free of Obstruction Requirements* for more information.

WARNING

Home builders and homeowners should consider the long-term effects of the construction of enclosures below elevated residential buildings and post-construction conversion of enclosed space to habitable use in A zones and V zones. Designers and owners should realize that (1) enclosures and items within them are likely to be destroyed even during minor flood events, (2) enclosures, and most items within them, are not covered by flood insurance and can result in significant costs to the building owner, and (3) even the presence of properly constructed enclosures will increase flood insurance premiums for the entire building (the premium rate will increase as the enclosed area increases). Including enclosures in a building design can have significant cost implications.

This *Home Builder's Guide to Coastal Construction* recommends the use of insect screening or open wood lattice instead of solid enclosures beneath elevated residential buildings.

Breakaway walls that failed under the flood forces of Hurricane Ivan.

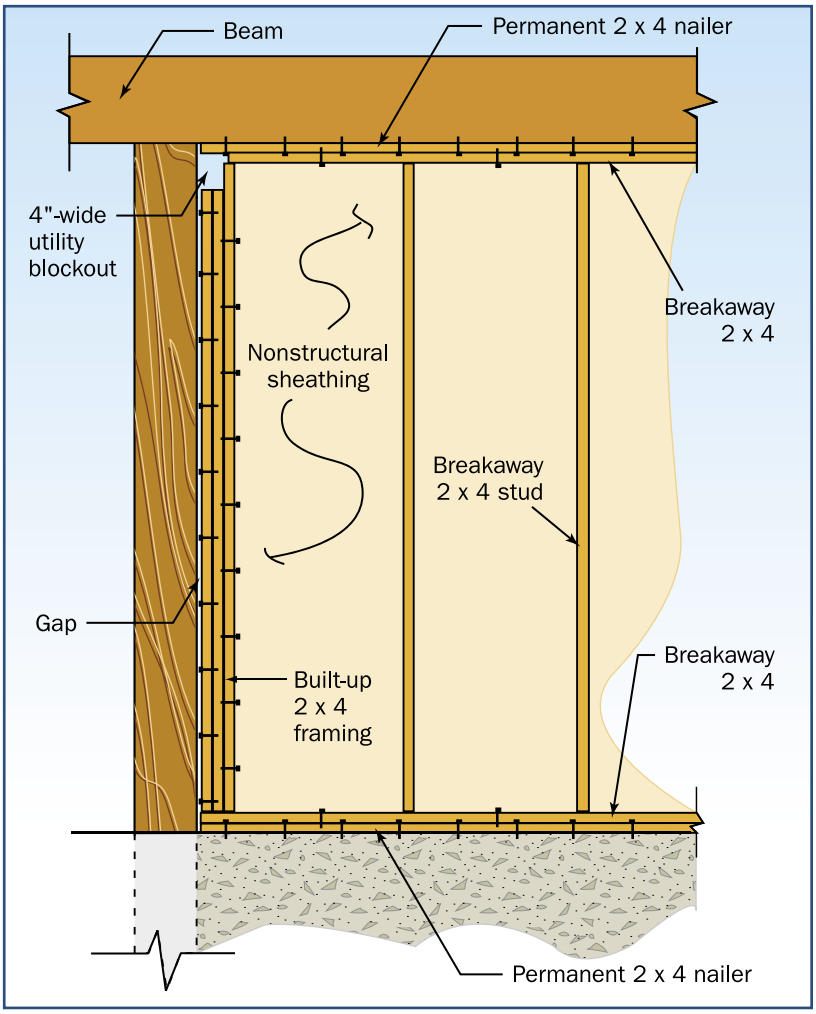
Enclosures can be divided into two types, ***breakaway*** and ***non-breakaway***.

- ***Breakaway*** enclosures are designed to fail under Base Flood conditions without jeopardizing the elevated building – ***any below-BFE enclosure in a V zone must be breakaway***. Breakaway enclosures are permitted in A zones but must be equipped with flood openings.
- ***Non-breakaway*** enclosures, under the NFIP, can be used in an A zone (they may or may not provide structural support to the elevated building), but they must be equipped with flood openings to allow the automatic entry and exit of floodwaters. ***The Home Builder's Guide to Coastal Construction recommends their use only in A zone areas subject to shallow, slow-moving floodwaters without breaking waves.***

Open wood lattice installed beneath an elevated house in a V zone.

Breakaway Walls

Breakaway walls must be designed to break free under the larger of the design wind load, the design seismic load, or 10 psf, acting perpendicular to the plane of the wall. If the loading at which the breakaway wall is intended to collapse exceeds 20 psf, ***the breakaway wall design must be certified.*** When certification is required, a registered engineer or architect must certify that the walls will collapse under a water load associated with the Base Flood and that the elevated portion of the building and its foundation will not be subject to collapse, displacement, or lateral movement under simultaneous wind and water loads. (See the sample certification at the bottom of page 2 of Fact Sheet No. 5.) ***Utilities should not be attached to or pass through breakaway walls.***



Recommended breakaway wall construction.

Flood Openings

Where permitted and used in A zones, foundation walls and enclosures must be equipped with openings that allow the ***automatic entry and exit of floodwaters.***

Note the following:

- Flood openings must be provided ***in at least two of the walls*** forming the enclosure.
- ***The bottom of each flood opening*** must be ***no more than 1 foot above the adjacent grade*** outside the wall.
- ***Louvers, screens, or covers*** may be installed over flood openings as long as they do not interfere with the operation of the openings during a flood.
- Flood openings may be ***sized*** according to either a prescriptive method (1 square inch of flood opening per square foot of enclosed area) or an engineering method (which must be certified by a registered engineer or architect).

Details concerning flood openings can be found in FEMA Technical Bulletin 4-93, *Openings in Foundation Walls*.

Other Considerations

Enclosures are strictly regulated because, if not constructed properly, they ***can transfer flood forces to the main structure*** (possibly leading to structural collapse). There are other considerations, as well:

- Owners may be tempted to convert enclosed areas below the BFE into habitable space, leading to life-safety concerns and uninsured losses. Construction without enclosures should be encouraged. Contractors ***should not stub out utilities in enclosures;*** utility stub-outs make it easier for owners to finish and occupy the space.
- Siding used on non-breakaway portions of a building should not be extended over breakaway walls. Instead, a clean separation should be provided so that any siding installed on breakaway walls is structurally independent of siding elsewhere on the building. Without such a separation, the failure of breakaway walls can result in damage to siding elsewhere on the building.
- Breakaway enclosures in V zones will result in ***substantially higher flood insurance premiums*** (especially where the enclosed area is 300 square feet or greater). Insect screening or lattice is recommended instead.
- If enclosures are constructed in ***A zones with the potential for breaking waves, open foundations with breakaway enclosures are recommended*** in lieu of foundation walls or crawlspaces. If breakaway walls are used, they must be equipped with flood openings that allow flood waters to enter the enclosure during smaller storms. Breakaway enclosures in A zones will ***not*** lead to higher flood insurance premiums.

Siding on the non-breakaway portions of this elevated building was extended over breakaway enclosure walls and was damaged when breakaway walls failed under flood forces.

- Garage doors installed in below-BFE enclosures of V-zone buildings — even reinforced and high-wind-resistant doors — must meet the performance requirement discussed in the **Breakaway Walls** section on page 2 of this fact sheet. Specifically, the doors must be designed to break free under the larger of the design wind load, the design seismic load, or 10 psf, acting perpendicular to the plane of the door. If the loading at which the door is intended to collapse is greater than 20 psf, ***the door must be designed and certified to collapse under Base Flood conditions***. See the **Breakaway Walls** section of this fact sheet for information about certification requirements.