Flood Damage-Resistant Materials Requirements

for Buildings Located in Special Flood Hazard Areas in accordance with the National Flood Insurance Program

Technical Bulletin 2 / August 2008

FEMA

Table of Contents

Introduction 1
NFIP Regulations 2
Required Use of Flood Damage-Resistant Materials 2
    Flood Damage-Resistant Material 2
    How Flood Damage-Resistant Materials Affect Flood Insurance Rates 3
Classification of Flood Damage-Resistant Materials 3
    Notes Regarding Classification of Materials 5
Fasteners and Connectors 12
Construction Examples 13
    Buildings in Zones A, AE, A1-A30, AR, AO, and AH 13
    Buildings in Zones V, VE, and V1-V30 14
Additional Uses of Flood Damage-Resistant Materials 14
    Accessory Structures 14
    Wet Floodproofing 15
    Buildings Outside of SFHAs 16
The NFIP 17
NFIP Technical Bulletins 17
Ordering Technical Bulletins 17
Further Information 18
Glossary 19

Revision to Table 2 footnote (*) made in October 2010.

Comments on the Technical Bulletins should be directed to:

Department of Homeland Security
FEMA Federal Insurance and Mitigation Administration
500 C Street, SW.
Washington, D.C. 20472

Technical Bulletin 2-08 replaces 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

Protecting buildings that are constructed in special flood hazard areas (SFHAs) from damage caused by flood forces is an important objective of the National Flood Insurance Program (NFIP). In support of this objective, the NFIP regulations include minimum building design criteria that apply to new construction, repair of substantially damaged buildings, and substantial improvement of existing buildings in SFHAs. The base flood is used to delineate SFHAs on Flood Insurance Rate Maps (FIRMs) prepared by the NFIP. The base flood is the flood that has a 1-percent chance of being equaled or exceeded in any given year (commonly called the "100-year" flood). Certain terms used in this Technical Bulletin are defined in the Glossary.

The NFIP regulations require the use of construction materials that are resistant to flood damage. The lowest floor of a residential building must be elevated to or above the base flood elevation (BFE), while the lowest floor of a non-residential building must be elevated to or above the BFE or dry floodproofed to the BFE.

All construction below the BFE is susceptible to flooding and must consist of flood damage-resistant building materials. The purpose of this Technical Bulletin is to provide current 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.

Table 1 describes five classes of materials ranging from those that are highly resistant to floodwater damage, to those that have no resistance to flooding. Materials are broadly described as structural materials and finish materials based on how they are used in normal construction practices. Table 2 lists materials by generic names, and notes whether the materials are acceptable or unacceptable for use below the BFE. All building materials are in some way fastened or connected to the structure. Fasteners and connectors, as described in this Technical Bulletin, also must be resistant to flood damage.

A brief description of the process used to identify or determine whether the materials listed are flood damage-resistant is provided, followed by some simplified examples with diagrams to illustrate the use of these materials below the BFE. Three additional circumstances where flood damage-resistant materials are used or recommended are described: accessory structures, limited use of wet floodproofing, and buildings outside of SFHAs.

Questions about use of flood damage-resistant materials should be directed to the appropriate local official, NFIP State Coordinating Office, or one of the Federal Emergency Management Agency's (FEMA's) Regional Offices.

Under the NFIP, the "lowest floor" is the floor of the lowest enclosed area of a building. An unfinished or flood-resistant enclosure that is used solely for parking of vehicles, building access, or storage is not the lowest floor, provided the enclosure is built in compliance with applicable requirements.

As used by the NFIP, an "enclosure" is an area that is enclosed on all sides by walls.

The NFIP defines a "basement" as any area that is below-grade on all sides. The regulations do not allow basements to extend below the BFE.

NFIP Regulations

The NFIP regulations for flood damage-resistant materials are codified in Title 44 of the Code of Federal Regulations, in Section 60.3(a)(3), which states that a community shall:

> *"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…"*

Proposals for substantial improvement of existing buildings in SFHAs, and proposals to repair those that have sustained substantial damage, must comply with the requirements for new construction. As part of issuing permits, community officials must review such proposals to determine whether they comply with the requirements, including the use of flood damage-resistant materials. Refer to the "Classification of Flood Damage-Resistant Materials" section of this Technical Bulletin for additional details. Further information on substantial improvement and substantial damage is found in *Answers to Questions About Substantially Damaged Buildings* (FEMA 213).

The NFIP 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 provisions apply to the building or site in question. All other applicable requirements of the State or local building codes must also be met for buildings in all flood hazard areas.

Required Use of Flood Damage-Resistant Materials

Flood Damage-Resistant Material

"Flood [damage]-resistant material" is defined by the NFIP as "any building product [material, component or system] 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 cosmetic repair. "Cosmetic repair" includes cleaning, sanitizing, and resurfacing (e.g., sanding, repair of joints, repainting) of the material. The cost of cosmetic repair should also be less than the cost of replacement of affected materials and systems. In addition to these requirements, individual materials that are considered flood damage-resistant must not cause degradation of adjacent materials or the systems of which the material is a part.

The *International Building Code*® (IBC®), by reference to ASCE 24 *Flood Resistant Design and Construction*, and the *International Residential Code*® (IRC®), require the use of flood damage-resistant materials.

All building materials below the BFE must be flood damage-resistant, 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 damage-resistant materials below the BFE. As noted in Table 2, **only Class 4 and Class 5 materials are acceptable for areas below the BFE in buildings in SFHAs**.

In some instances, materials that are not flood damage-resistant materials, such as wiring for fire alarms and emergency lighting, are allowed below the BFE if specifically required to address life safety and electric code requirements for building access and storage areas.

How Flood Damage-Resistant Materials Affect Flood Insurance Rates

Careful attention to compliance with the NFIP regulations for flood damage-resistant materials is important during design, plan review, construction, and inspection. Compliance influences both the building's vulnerability to flood damage and the cost of NFIP flood insurance. Flood insurance will not pay a claim for finish materials located in basements or in enclosed areas below the lowest floor of elevated buildings, even if such materials are considered to be flood damage-resistant. NFIP claims for damage below the BFE are limited to utilities and equipment, such as furnaces and water heaters.

Classification of Flood Damage-Resistant Materials

The information in this Technical Bulletin was initially developed based on information in the U.S. Army Corps of Engineers' *Flood Proofing Regulations* (1995), and has been updated based on additional information from FEMA-funded studies and reports, technical experts, and industry and trade groups. Table 1 classifies building materials according to their ability to resist flood damage.

Table 1. Class Descriptions of Materials

NFIP	Class	Class Description
ACCEPTABLE	5	Highly resistant to floodwater[1] damage, including damage caused by moving water.[2] These materials can survive wetting and drying and may be successfully cleaned after a flood to render them free of most harmful pollutants.[3] Materials in this class are permitted for partially enclosed or outside uses with essentially unmitigated flood exposure.
	4	Resistant to floodwater[1] damage from wetting and drying, but less durable when exposed to moving water.[2] These materials can survive wetting and drying and may be successfully cleaned after a flood to render them free of most harmful pollutants.[3] Materials in 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[4] damage, but not floodwater damage. Materials in this class may be submerged in clean water during periods of flooding. These materials can survive wetting and drying, but may not be able to be successfully cleaned after floods to render them free of most[3] harmful pollutants.
	2	Not resistant to clean water[4] damage. Materials in this class are used in predominantly dry spaces that may be subject to occasional water vapor and/or slight seepage. These materials cannot survive the wetting and drying associated with floods.
	1	Not resistant to clean water[4] damage or moisture damage. Materials in this class are used in spaces with conditions of complete dryness. These materials cannot survive the wetting and drying associated with floods.

Notes:

1. Floodwater is assumed to be considered "black" water; black water contains pollutants such as sewage, chemicals, heavy metals, or other toxic substances that are potentially hazardous to humans.
2. Moving water is defined as water moving at low velocities of 5 feet per second (fps) or less. Water moving at velocities greater than 5 fps may cause structural damage to building materials.
3. Some materials can be successfully cleaned of most of the pollutants typically found in floodwater. However, some individual pollutants such as heating oil can be extremely difficult to remove from uncoated concrete. These materials are flood damage-resistant except when exposed to individual pollutants that cannot be successfully cleaned.
4. Clean water includes potable water as well as "gray" water; gray water is wastewater collected from normal uses (laundry, bathing, food preparation, etc.).

MODIFIED FROM: USACE 1995 *Flood Proofing Regulations*

Table 2 lists structural materials and finish materials commonly used in construction of floors, walls, and ceilings. For the purpose of this Technical Bulletin, structural materials and finish materials are defined as follows:

- **Structural materials** include all elements necessary to provide structural support, rigidity, and integrity to a building or building component. Structural materials include floor slabs, beams, subfloors, framing, and structural building components such as trusses, wall panels, I-joists and headers, and interior/exterior sheathing.

- **Finish materials** include all coverings, finishes, and elements that do not provide structural support or rigidity to a building or building component. Finish materials include floor coverings, wall and ceiling surface treatments, insulation, cabinets, doors, partitions, and windows.

Notes Regarding Classification of Materials

The classifications in Table 2 are based on the best information available at the time of publication. However, flood damage-resistance is determined by factors that may be a function of the specific application and by the characteristics of the floodwaters. Each situation requires sound judgment and knowledge of probable contaminants in local floodwaters to select materials that are required to resist flood damage. For materials and products that are listed in Table 2, manufacturers' use and installation instructions must be followed to ensure maximum performance. Masonry and wood products used below the BFE must comply with the applicable standards published by the American Society for Testing and Materials (ASTM), the American Concrete Institute (ACI), the Truss Plate Institute (TPI), the American Forest & Paper Association (AF&PA), and other appropriate organizations.

1. **Materials Not Listed:** Table 2 does not list all available structural materials and finish materials. For materials and products not listed, manufacturers' literature (i.e., specifications, materials safety data sheets, test reports) should be evaluated to determine if the product meets flood damage-resistance requirements. Materials and products that are not listed in Table 2 may be used if accepted by the local official. Acceptance should be based on sufficient evidence, provided by the applicant, that the materials proposed to be used below the BFE will resist flood damage without requiring more than cosmetic repair and cleaning.

2. **Unacceptable Materials:** Class 1, 2, and 3 materials are unacceptable 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 groundwater seepage and vapor.

   - The materials contain wood or paper products, or other materials that dissolve or deteriorate, lose structural integrity, or are adversely affected by water.

   - Sheet-type floor coverings (linoleum, rubber tile) or wall coverings (wallpaper) restrict drying of the materials they cover.

   - Materials are dimensionally unstable.

   - Materials absorb or retain excessive water after submergence.

3. **Impact of Material Combinations:** In some cases, the combination of acceptable structural and finish materials can negatively impact the classification of individual materials. This is illustrated by the following examples:

- Vinyl tile with chemical-set adhesives is an acceptable finish flooring material when placed on a concrete structural floor. However, when the same vinyl tile is applied over a plywood structural floor, it is no longer considered acceptable because the vinyl tile must be removed to allow the plywood to dry.

- Polyester-epoxy or oil-based paints are acceptable wall finishes when applied to a concrete structural wall. However, when the same paint is applied to a wood wall, it is no longer considered acceptable. Recent FEMA-supported studies by Oak Ridge National Laboratory have found that low-permeability paint can inhibit drying of the wood wall.

4. **Impact of Long-Duration Exposure and/or Contaminants:** The classifications of materials listed in Table 2 do not take into account the effects of long-duration exposure to floodwaters or contaminants carried by floodwaters. This is illustrated by the following examples:

   - Following Hurricane Katrina, FEMA deployed a Mitigation Assessment Team (MAT) to examine how building materials performed after long-duration exposure (2 to 3 weeks) to floodwaters (FEMA 549). The field survey revealed that some materials absorbed floodborne biological and chemical contaminants. However, it is not known at this time if a shorter duration flood event would have significantly altered the absorption rates of those contaminants.

   - Building owners, design professionals, and local officials should consider potential exposure to floodborne contaminants when selecting flood damage-resistant materials. For example, Table 2 lists cast-in-place concrete, concrete block, and solid structural wood (2x4s, etc.), as acceptable flood damage-resistant materials. However, experience has shown that buildings with those materials can be rendered unacceptable for habitation after being subjected to floodwaters with significant quantities of petroleum-based products such as home heating oil. Commonly used cleaning and remediation practices do not reduce the "off-gassing" of volatile hydrocarbons from embedded oil residues to acceptable levels that are established by the U.S. Environmental Protection Agency. Other materials, when exposed to these types of contaminants, may also not perform acceptably as flood damage-resistant materials.

Table 2. Types, Uses, and Classifications of Materials

Types of Building Materials	Uses of Building Materials		Classes of Building Materials				
			Acceptable		Unacceptable		
	Floors	Walls/ Ceilings	5	4	3	2	1
Structural Materials (floor slabs, beams, subfloors, framing, and interior/exterior sheathing)							
Asbestos-cement board		■	■				
Brick							
Face or glazed		■	■				
Common (clay)		■		■			
Cast stone (in waterproof mortar)		■	■				
Cement board/fiber-cement board		■	■				
Cement/latex, formed-in-place	■			■			
Clay tile, structural glazed		■	■				
Concrete, precast or cast-in-place	■	■	■				
Concrete block[1]		■	■				
Gypsum products							
Paper-faced gypsum board		■			■		
Non-paper-faced gypsum board		■		■			
Greenboard		■				■	
Keene's cement or plaster		■			■		
Plaster, otherwise, including acoustical		■				■	
Sheathing panels, exterior grade		■			■		
Water-resistant, fiber-reinforced gypsum exterior sheathing		■		■			
Hardboard (high-density fiberboard)							
Tempered, enamel or plastic coated		■				■	
All other types		■					■
Mineral fiberboard		■					■
Oriented-strand board (OSB)							
Exterior grade	■	■				■	
Edge swell-resistant OSB	■	■				■	
All other types	■	■					■
Particle board	■						■
Plywood							
Marine grade	■	■	■				
Preservative-treated, alkaline copper quaternary (ACQ) or copper azole (C-A)	■	■		■			

Table 2. Types, Uses, and Classifications of Materials (continued)

Types of Building Materials	Uses of Building Materials		Classes of Building Materials				
			Acceptable		Unacceptable		
	Floors	Walls/ Ceilings	5	4	3	2	1
Structural Materials (floor slabs, beams, subfloors, framing, and interior/exterior sheathing)							
Preservative-treated, Borate[2]	■	■	■				
Exterior grade/Exposure1 (WBP – weather and boil proof)	■	■		■			
All other types	■	■					■
Recycled plastic lumber (RPL)							
Commingled, with 80-90% polyethylene (PE)	■		■				
Fiber-reinforced, with glass fiber strands	■		■				
High-density polyethylene (HDPE), up to 95%	■		■				
Wood-filled, with 50% sawdust or wood fiber	■				■		
Stone							
Natural or artificial non-absorbent solid or veneer, waterproof grout	■	■	■				
All other applications		■				■	
Structural Building Components							
Floor trusses, wood, solid (2x4s), decay-resistant or preservative-treated	■	■		■			
Floor trusses, steel[3]	■		■				
Headers and beams, solid (2x4s) or plywood, exterior grade or preservative-treated		■		■			
Headers and beams, OSB, exterior grade or edge-swell resistant		■				■	
Headers and beams, steel[3]		■	■				
I-joists	■					■	
Wall panels, plywood, exterior grade or preservative-treated		■		■			
Wall panels, OSB, exterior grade or edge-swell resistant		■				■	
Wall panels, steel[3]		■		■			

Table 2. Types, Uses, and Classifications of Materials (continued)

Types of Building Materials	Uses of Building Materials		Classes of Building Materials				
			Acceptable		Unacceptable		
	Floors	Walls/ Ceilings	5	4	3	2	1
Structural Materials (floor slabs, beams, subfloors, framing, and interior/exterior sheathing)							
Wood							
Solid, standard, structural (2x4s)		■		■			
Solid, standard, finish/trim		■			■		
Solid, decay-resistant[4]	■	■	■				
Solid, preservative-treated, ACQ or C-A		■		■			
Solid, preservative-treated, Borate[2]		■		■			
Finish Materials (floor coverings, wall and ceiling finishes, insulation, cabinets, doors, partitions, and windows)							
Asphalt tile[5]							
With asphaltic adhesives	■				■		
All other types	■						■
Cabinets, built-in							
Wood		■				■	
Particle board		■					■
Metal[3]		■		■			
Carpeting	■						■
Ceramic and porcelain tile							
With mortar set	■	■		■			
With organic adhesives	■	■				■	
Concrete tile, with mortar set	■		■				
Corkboard		■				■	
Doors							
Wood, hollow		■				■	
Wood, lightweight panel construction		■				■	
Wood, solid		■				■	
Metal, hollow[3]		■		■			
Metal, wood core[3]		■		■			
Metal, foam-filled core[3]		■		■			
Fiberglass, wood core		■		■			
Epoxy, formed-in-place	■		■				

Table 2. Types, Uses, and Classifications of Materials (continued)

Types of Building Materials	Uses of Building Materials		Classes of Building Materials				
			Acceptable		Unacceptable		
	Floors	Walls/ Ceilings	5	4	3	2	1
Finish Materials (floor coverings, wall and ceiling finishes, insulation, cabinets, doors, partitions, and windows)							
Glass (sheets, colored tiles, panels)		■		■			
Glass blocks		■	■				
Insulation							
Sprayed polyurethane foam (SPUF) or closed-cell plastic foams	■	■	■				
Inorganic – fiberglass, mineral wool: batts, blankets, or blown	■	■			■		
All other types (cellulose, cotton, open-cell plastic foams, etc.)	■	■				■	
Linoleum	■						■
Magnesite (magnesium oxychloride)	■						■
Mastic felt-base floor covering	■						■
Mastic flooring, formed-in-place	■		■				
Metals, non-ferrous (aluminum, copper, or zinc tiles)		■			■		
Metals							
Non-ferrous (aluminum, copper, or zinc tiles)		■			■		
Metals, ferrous[3]		■		■			
Paint							
Polyester-epoxy and other oil-based waterproof types		■		■			
Latex		■		■			
Partitions, folding							
Wood		■				■	
Metal[3]		■		■			
Fabric-covered		■					■
Partitions, stationary (free-standing)							
Wood frame		■		■			
Metal[3]		■		■			
Glass, unreinforced		■		■			
Glass, reinforced		■		■			
Gypsum, solid or block		■					■

Table 2. Types, Uses, and Classifications of Materials (continued)

Types of Building Materials	Uses of Building Materials		Classes of Building Materials				
			Acceptable		Unacceptable		
	Floors	Walls/ Ceilings	5	4	3	2	1
Finish Materials (floor coverings, wall and ceiling finishes, insulation, cabinets, doors, partitions, and windows)							
Polyurethane, formed-in-place	■		■				
Polyvinyl acetate (PVA) emulsion cement	■						■
Rubber							
Moldings and trim with epoxy polyamide adhesive or latex-hydraulic cement		■		■			
All other applications		■					■
Rubber sheets or tiles[5]							
With chemical-set adhesives[6]	■		■				
All other applications	■						■
Silicone floor, formed-in-place	■		■				
Steel (panels, trim, tile)							
With waterproof adhesives[3]		■	■				
With non-waterproof adhesives		■				■	
Terrazo	■			■			
Vinyl asbestos tile (semi-flexible vinyl)[5]							
With asphaltic adhesives	■		■				
All other applications	■						■
Vinyl sheets or tiles (coated on cork or wood product backings)	■						■
Vinyl sheets or tiles (homogeneous)[5]							
With chemical-set adhesives[6]	■			■			
All other applications	■						■
Wall coverings							
Paper, burlap, cloth types		■					■
Vinyl, plastic, wall paper		■					■
Wood floor coverings							
Wood (solid)	■						■
Engineered wood flooring	■					■	
Plastic laminate flooring	■					■	
Wood composition blocks, laid in cement mortar	■					■	
Wood composition blocks, dipped and laid in hot pitch or bitumen	■					■	

Notes*:

1 Unfilled concrete block cells can create a reservoir that can hold water following a flood, which can make the blocks difficult or impossible to clean if the floodwaters are contaminated.

2 Borate preservative-treated wood meets the NFIP requirements for flood damge-resistantce; however, the borate can leach out of the wood if the material is continuously exposed to standing or moving water.

3 Not recommended in areas subject to salt-water flooding.

4 Examples of decay-resistant lumber include heart wood of redwood, cedar, and black locust. Refer to Section 2302 of the International Building Code® (IBC®) and Section R202 of the International Residential Code® (IRC®) for guidance.

5 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).

6 Examples include epoxy-polyamide adhesives or latex-hydraulic cement.

* In addition to the requirements of TB 2 for flood damage resistance, building materials must also comply with any additional requirements of applicable building codes. For example, for wood products such as solid 2x4s and plywood, applicable building code requirements typically include protection against decay and termites and will specify use of preservative-treated or decay-resistant wood for certain applications. Applications that require preservative-treated or decay-resistant species include wood in contact with the ground, wood exposed to weather, wood on exterior foundation walls, or wood members close to the exposed ground. In some cases, applicable building code requirements (such as those in ASCE 24-05 and IRC 2006) do not reflect updated guidance in TB 2 and specify that all wood used below the design flood elevation be preservative-treated or naturally decay-resistant regardless of proximity to ground or exposure to weather. (Revision made in October 2010)

Fasteners and Connectors

The term “fasteners” typically refers to nails, screws, bolts, and anchors. The term “connectors” typically refers to manufactured devices used to connect two or more building components. Joist hangers, post bases, hurricane ties and clips, and mud-sill anchors are examples of connectors. Fasteners and connectors are materials and thus must be made of flood damage-resistant materials in order to comply with the NFIP requirements.

Specifications for fasteners and connectors used in buildings in SFHAs are in ASCE 24, a standard referenced by the IBC. Chapter 23 of the IBC has specific requirements for connections and fasteners used with wood, including preservative-treated wood. Similar specifications are in Chapter 3 of the IRC.

Table 2 does not specifically address fasteners and connectors. However, it is clear that the performance of buildings that are exposed to flooding is, at least in part, a function of the fasteners and connectors used to put the components together. When preservative-treated woods are used, particular attention is required for fasteners and connectors because some treatments are more corrosive than others, which could shorten the service life of the fasteners and connectors. For example, alkaline copper quaternary (ACQ) treatments are more corrosive than traditional acid copper chromate (ACC) treatments. If corrosion occurs, buildings are less likely to withstand flood loads and other loads. Fasteners and connectors made of stainless steel, hot-dipped zinc-coated galvanized steel, silicon bronze, or copper are recommended for use with preservative-treated wood.

This Technical Bulletin, consistent with ASCE 24 and the International Code Series, recommends that stainless steel or hot-dip galvanized fasteners and connectors be used below the BFE in both inland (noncorrosive) and coastal (corrosive) areas. In coastal environments where airborne salts contribute to corrosion, it is recommended that corrosion-resistant fasteners and connectors be used throughout the building where they may be exposed. For

additional guidance, see Technical Bulletin 8, *Corrosion Protection for Metal Connectors in Coastal Areas*. Also see TPI/WTCA *Guidelines for Use of Alternative Preservative Treatments with Metal Connector Plates* for further guidance on metal plate connected wood trusses manufactured with preservative treated lumber (http://www.sbcindustry.com/images/PTWGuidelines.pdf).

Construction Examples

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

Figure 1 illustrates a solid foundation wall (crawlspace) elevated to meet the minimum requirement that the lowest floor be at the BFE. Figure 2 illustrates framed walls that may be used for enclosures below the BFE that are used for parking of vehicles, building access, and storage.

To maximize allowable use of enclosures below the BFE, it is a common practice to extend the foundation a full story, even though that puts the lowest floor well above the BFE. In such cases, while the NFIP requirement is that flood damage-resistant materials be used only below the BFE, it is strongly recommended that such materials be used for all construction below the lowest floor. This will reduce flood damage to the enclosed area in the event flooding exceeds the BFE. For additional guidance on enclosures in A zones, see Technical Bulletin 1, *Openings in Foundation Walls and Walls of Enclosures Below Elevated Buildings in Special Flood Hazard Areas*.

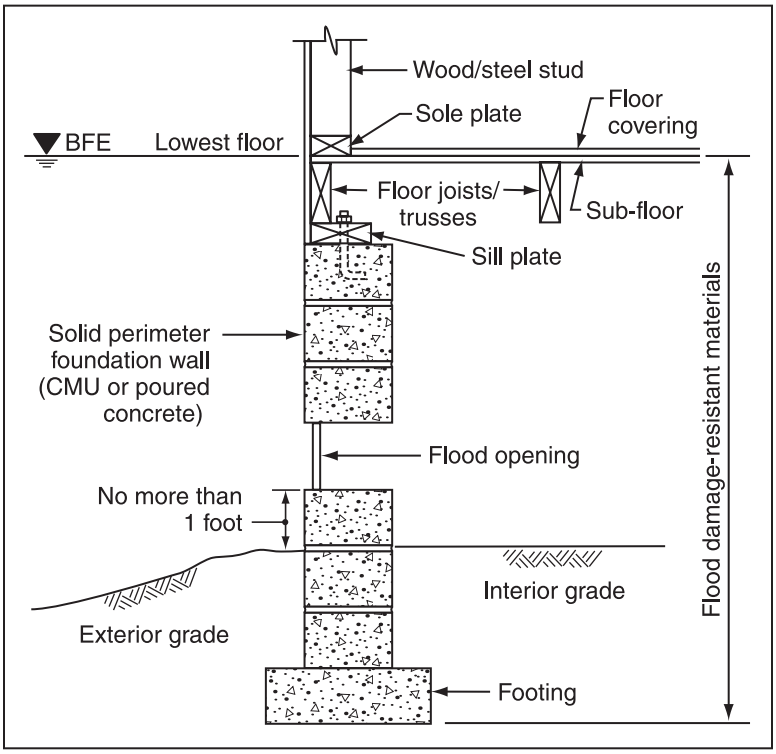

Figure 1. Building elevated on solid foundation walls meeting the minimum NFIP requirements for Zones A, AE, A1-A30, AR, AO, and AH

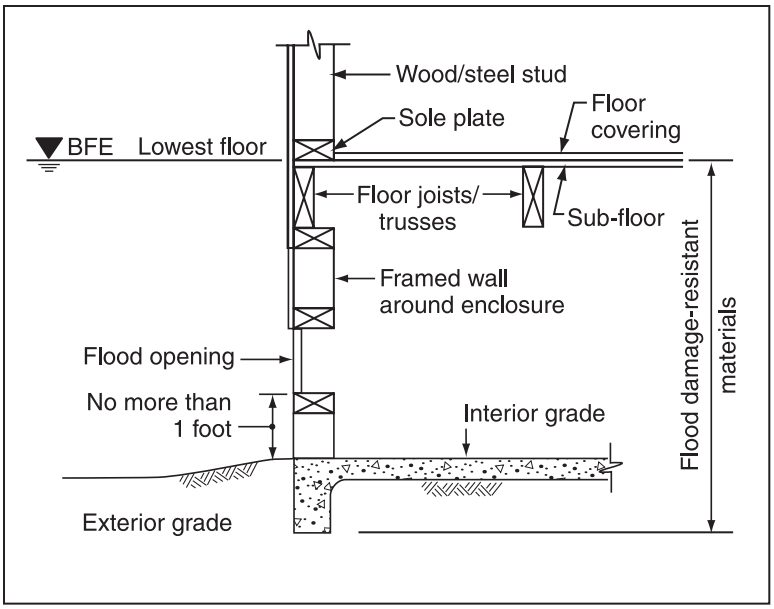

Figure 2. Framed enclosure under building elevated in accordance with NFIP requirements for Zones A, AE, A1-A30, AO, and AH

Buildings in Zones V, VE, and V1-V30

The NFIP regulations require that the bottom of the lowest horizontal structural member of the lowest floor (usually the floor beam or girder) of buildings in Zones V, VE, and Vl-V30 be at or above the BFE. Therefore, all materials below the bottom of those members must be flood damage-resistant materials. This requirement applies to lattice work and screening, and also to materials used to construct breakaway walls that enclose areas below the lowest floor. Depending on the design parameters selected, breakaway walls may remain in place during low-level floods and must be flood damage-resistant so that they can be readily cleaned and not deteriorate over time due to wetting. Figure 3 illustrates the requirement. For additional guidance on breakaway walls used to enclose areas under buildings in V zones, see Technical Bulletin 9, *Design and Construction Guidance for Breakaway Walls Below Elevated Coastal Buildings*.

Additional Uses of Flood Damage-Resistant Materials

Accessory Structures

Accessory structures may be allowed in SFHAs provided they are located, installed, and constructed in ways that comply with NFIP requirements. Some communities allow accessory structures that are limited to the uses specified for enclosures below the BFE: parking of vehicles and storage. As with other buildings, accessory structures below the BFE are required to be constructed with flood damage-resistant materials. In addition, accessory structures must be anchored to resist flotation, collapse, and lateral movement and comply with other requirements based on the flood zone. For additional information and requirements, contact the appropriate community permitting office.

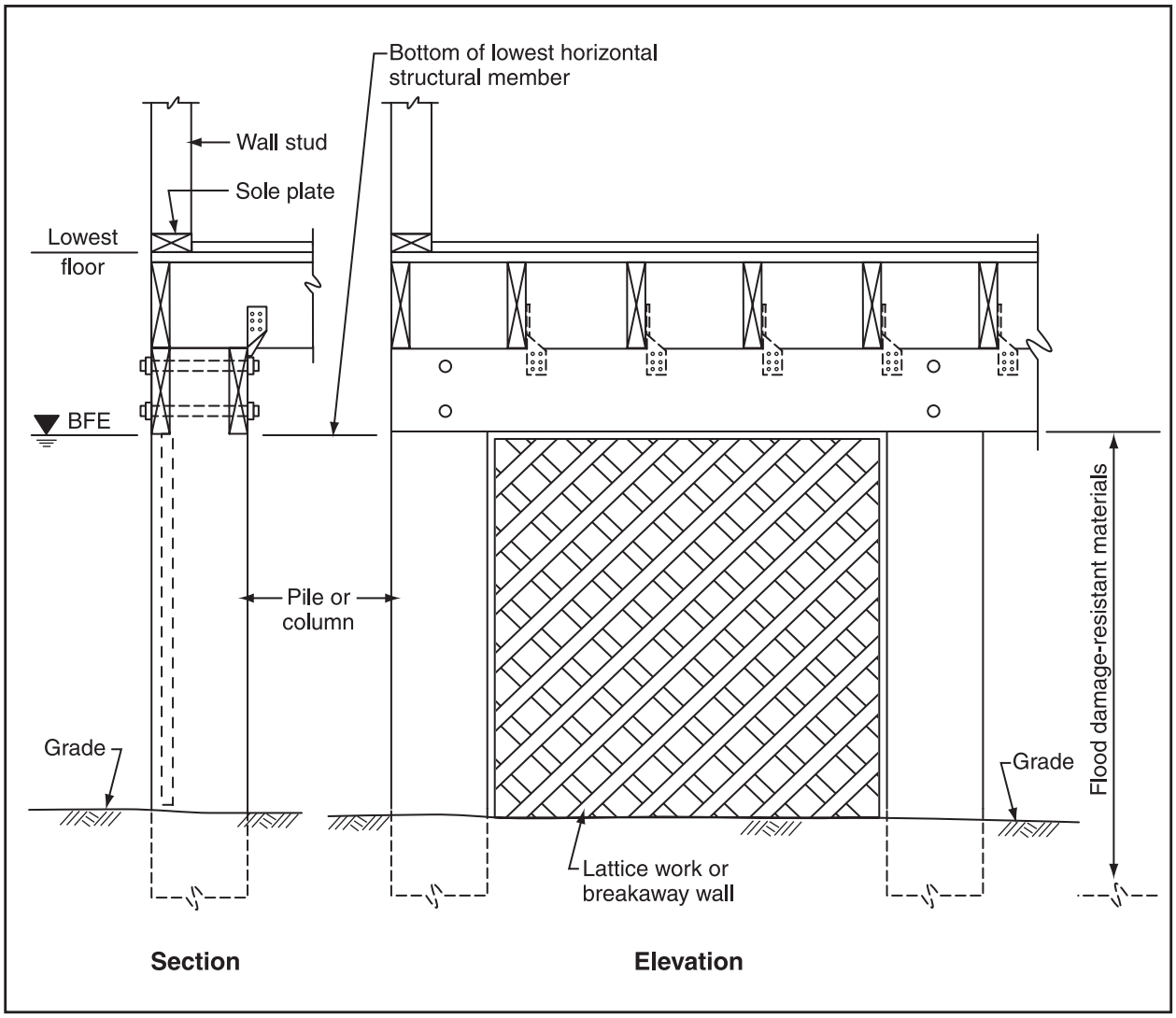

Figure 3. Flood damage-resistant building material requirements for buildings elevated in accordance with NFIP requirements for Zones V, VE, and V1-V30

Wet Floodproofing

Wet floodproofing is a method to reduce damage that typically involves three elements: allowing floodwaters to enter and exit to minimize structural damage, using flood damage-resistant materials, and elevating utility service and equipment. When a building is retrofitted to be wet floodproofed, non-flood damage-resistant materials that are below the BFE should be removed and replaced with flood damage-resistant materials. This will reduce the costs of repair and facilitate faster recovery.

Wet floodproofing is not allowed in lieu of complying with the lowest floor elevation requirements for new residential buildings (or dry floodproofing of nonresidential buildings in A zones). The exception is accessory structures, as noted on the previous page. Wet floodproofing may also be used to voluntarily retrofit buildings that are older than the date of the community's first FIRM (commonly referred to as "pre-FIRM"), provided the requirement to

bring such buildings into compliance is not triggered (called "substantial improvement"). Figure 4 illustrates some suggested retrofitting of interior walls in a pre-FIRM building. However, please note that the techniques illustrated in Figure 4 cannot be used to bring a substantially damaged or substantially improved building into compliance with the NFIP. For additional information on wet floodproofing, see Technical Bulletin 7, *Wet Floodproofing Requirements*.

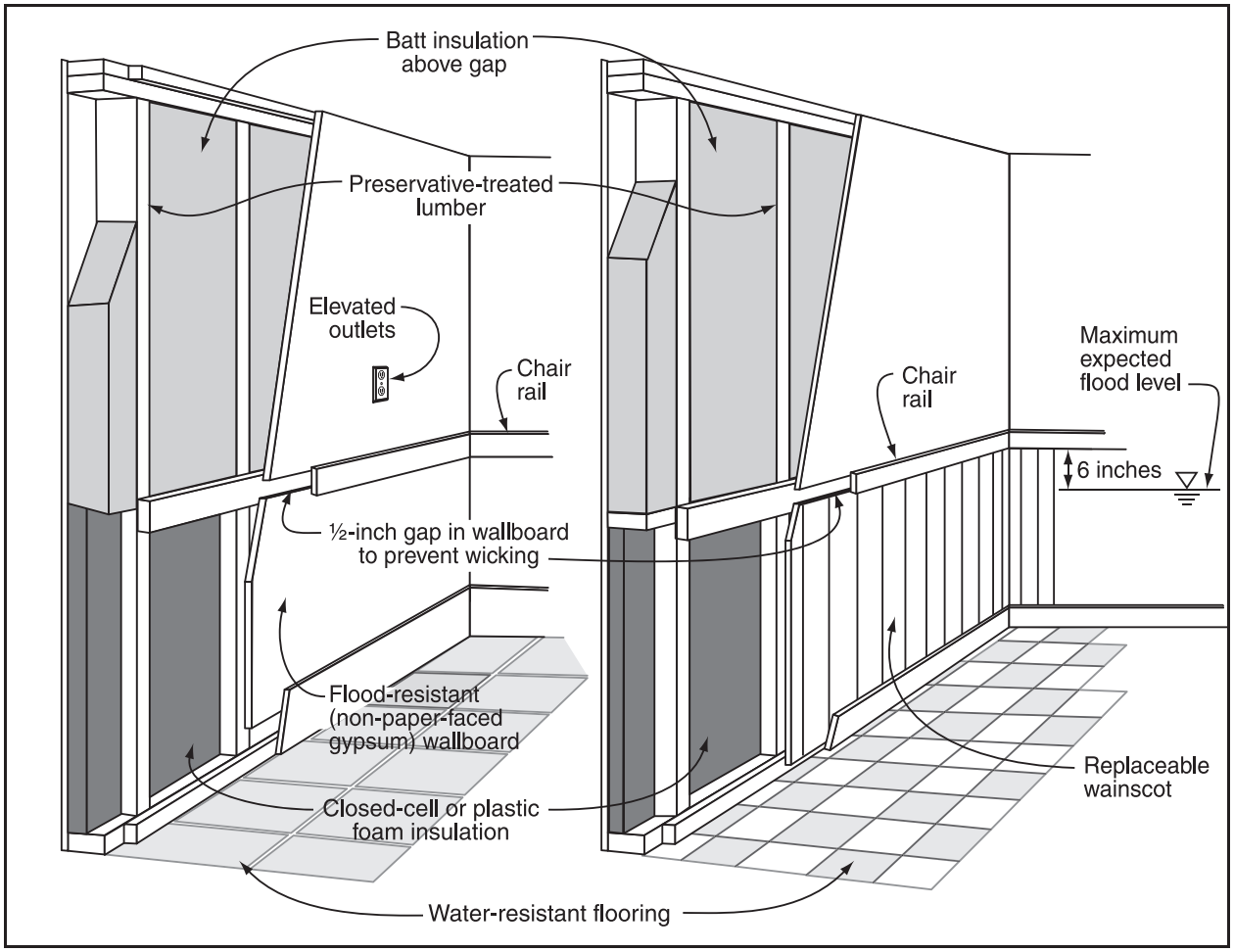

Figure 4. Partial wet floodproofing technique using flood damage-resistant materials for finished wall construction.

Buildings Outside of SFHAs

FEMA reports that up to 25 percent of NFIP flood insurance claims are paid on buildings that are outside of the mapped SFHA. This occurs for many reasons, including out-of-date maps and local drainage problems. In areas known to be prone to flooding that are not subject to the NFIP requirements, it is recommended that flood damage-resistant materials be used for construction of new buildings and for repair or renovation of existing buildings. Figure 4 illustrates some options.

The NFIP

The U.S. Congress established the NFIP with the passage of the National Flood Insurance Act of 1968. The NFIP is a Federal program enabling property owners in participating communities to purchase insurance as protection against flood losses, in exchange for State and community floodplain management regulations that reduce future flood damages. Participation in the NFIP is based on an agreement between communities and the Federal Government. If a community adopts and enforces adequate floodplain management regulations, FEMA will make flood insurance available within the community.

Title 44 of the U.S. Code of Federal Regulations contains the NFIP criteria for floodplain management, including design and construction standards for new and substantially improved buildings located in SFHAs identified on the NFIP's FIRMs. FEMA encourages communities to adopt floodplain management regulations that exceed the NFIP criteria. As an insurance alternative to disaster assistance, the NFIP reduces the escalating costs of repairing damage to buildings and their contents caused by floods.

NFIP Technical Bulletins

This is one of a series of Technical Bulletins that FEMA has produced to provide guidance concerning the building performance requirements of the NFIP. These requirements are contained in Title 44 of the U.S. Code of Federal Regulations at Section 60.3. The bulletins are intended for use by State and local officials responsible for interpreting and enforcing the requirements in their floodplain management regulations and building codes, 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 requirements of existing NFIP regulations. Users of the Technical Bulletins who need additional guidance should contact their NFIP State Coordinator or the appropriate FEMA regional office. *The User's Guide to Technical Bulletins* (http://www.fema.gov/pdf/fima/guide01.pdf) lists the bulletins issued to date.

Ordering Technical Bulletins

The quickest and easiest way to acquire copies of FEMA's Technical Bulletins is to download them from the FEMA website (http://www.fema.gov/plan/prevent/floodplain/techbul.shtm).

Technical Bulletins also may be ordered free of charge from the FEMA Distribution Center by calling 1-800-480-2520, or by faxing a request to 1-240-699-0525, Monday through Friday between 8 a.m. and 5 p.m. EST. Please provide the FEMA publication number, title, and quantity of each publication requested, along with your name, address, zip code, and daytime telephone number. Written requests may be submitted by email to: FEMA-Publications-Warehouse@dhs.gov

Further Information

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

Algan, H. and Wendt, R. 2005. *Pre-Standard Development for the Testing of Flood-Damage-Resistant Residential Envelope Systems, Comparison of Field and Laboratory Results - Summary Report*, Oak Ridge National Laboratory, June 2005.

American Red Cross, FEMA. 1992. *Repairing Your Flooded Home*, FEMA 232, ARC 4477.

American Society of Civil Engineers, Structural Engineering Institute. 2005. *Flood Resistant Design and Construction*, ASCE/SEI 24-05.

American Society of Civil Engineers, Structural Engineering Institute. 2005. *Minimum Design Loads for Buildings and Other Structures*, ASCE/SEI 7-05.

Brick Institute of America, n.d. *Technical Notes for Brick Construction*, Brick Institute of America, McLean, Virginia.

California Integrated Waste Management Board. 2004. "Recycled Plastic Lumber," California Integrated Waste Management Board, web page, last updated June 22, 2004 (http://www.ciwmb.ca.gov/Plastic/Recycled/Lumber).

Department of Energy. 2005. *Energy-Efficient Flood-Damage-Resistant Home Reconstruction*, (http://www.ornl.gov/sci/res_buildings/FEMA-attachments/Flood_damage-reconstruction.pdf).

FEMA. 1991. *Answers to Questions About Substantially Damaged Buildings*, FEMA 213.

FEMA. 1993. *Wet Floodproofing Requirements*, Technical Bulletin 7-93, FIA-TB-7.

FEMA. 1996. *Corrosion Protection for Metal Connectors in Coastal Areas*, Technical Bulletin 8-96, FIA-TB-8.

FEMA. 2000. *Coastal Construction Manual*, FEMA 55CD (3rd edition).

FEMA. 2005. *Home Builder's Guide to Coastal Construction: Technical Fact Sheet Series*, FEMA 499.

FEMA. 2006. *Mitigation Assessment Team Report: Hurricane Katrina in the Gulf Coast*, FEMA 549.

FEMA. 2007. *National Flood Insurance Program: Flood Insurance Manual*, Revised October 2007.

International Code Council, Inc. 2006. International Building Code®, IBC® 2006.

International Code Council, Inc. 2006. International Residential Code®, IRC® 2006.

Simpson Strong-Tie. 2008. *Technical Bulletin: Preservative-Treated Wood*, Simpson Strong-Tie T-PTWOOD08-R, July 2008 (http://www.strongtie.com/ftp/bulletins/T-PTWOOD08-R.pdf).

TPI/WTCA. 2004. TPI/WTCA *Guidelines for Use of Alternative Preservative Treatments with Metal Connector Plates*, updated June 4, 2007, (http://www.sbcindustry.com/images/PTWGuidelines.pdf).

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

U.S. Army Corps of Engineers. 1995. *Flood Proofing Regulations*, Chapters 9 and 10, U.S. Army Corps of Engineers, EP 1165-2-314.

Wood Truss Council of America (WTCA). 2005. *The Load Guide: Guide to Good Practice for Specifying and Applying Loads to Structural Building Components*, (http://www.sbcindustry.com/loads.php).

World Floor Covering Association (WFCA). n.d., Anaheim, California (http://www.wfca.org/index.html).

Glossary

Accessory structure — A structure that is on the same parcel of property as a principal structure, the use of which is incidental to the use of the principal structure.

Base flood — The flood having a 1-percent chance of being equaled or exceeded in any given year, commonly referred to as the "100-year flood." The base flood is the national standard used by the NFIP and all Federal agencies for the purposes of requiring the purchase of flood insurance and regulating new development.

Base flood elevation (BFE) — The height of the base (1-percent annual chance or 100-year) flood in relation to a specified datum, usually the National Geodetic Vertical Datum of 1929, or the North American Vertical Datum of 1988.

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

Enclosure or enclosed area — Areas created by a crawlspace or solid walls that fully enclose areas below the BFE.

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

Federal Insurance and Mitigation Administration (FIMA) — The component of FEMA directly responsible for administering the flood hazard identification and floodplain management aspects of the NFIP.

Flood Insurance Rate Map (FIRM) — The official map of a community on which FEMA has delineated both the special flood hazard areas (SFHAs) and the risk premium zones applicable to the 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 usable solely for parking of vehicles, building access, or storage (in an area other than a basement) is not considered a building's lowest floor, provided the enclosure does not render the structure in violation of the applicable design requirements of the NFIP.

Registered Design Professional — An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the State or jurisdiction in which the project is to be constructed.

Special Flood Hazard Area (SFHA) — An area delineated on a FIRM as being subject to inundation by the base flood and designated as Zone A, AE, A1-A30, AR, AO, AH, A99, 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. Structures that are determined to be substantially damaged are considered to be substantial improvements, regardless of the actual repair work performed.

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 (or smaller percentage if established by the community) before the "start of construction" of the improvement. This term includes structures that have incurred "substantial damage," regardless of the actual repair work performed.