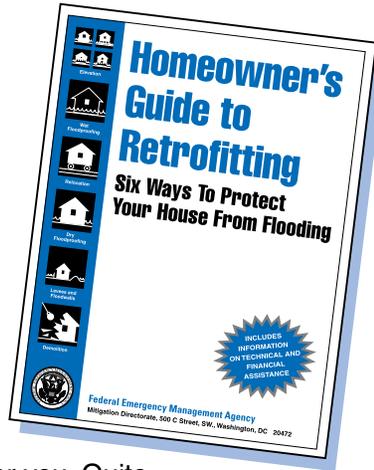


Who The Guide Is For

As a homeowner, you need clear information about the options that are available to reduce flood damage to your home – and straightforward guidance on selecting the option that is best for you. Quite often this is a difficult task. The publication described here is for readers who have little or no knowledge of flood protection methods or building construction techniques.



You should take action to avoid repetitive flood damage to your house. First, you need to know what damage-reduction methods are available, the degree to which they work, how much they cost, and whether they meet your needs. All of these questions are answered by the guide. In addition, the guide explains how the degree of flood risk varies from one location to another. By knowing the basic questions to ask, you are guided towards the investment in retrofitting that is appropriate for you.

You can download FEMA 312, or parts of it, from FEMA's web site – <http://www.fema.gov/mit/rfit/>



Some retrofitting techniques may not be used in certain circumstances under state or local laws, ordinances, or regulations.

Want To Learn More?

Homeowner's Guide to Retrofitting: Six Ways To Protect Your House From Flooding is FEMA publication 312.

Call 1-800-737-8669 to get a copy of this important guide. For copies of other FEMA publications, including those listed below, call 1-800-480-2520.

Related Publications

- **FEMA 55**
Coastal Construction Manual
- **FEMA 257**
Mitigation of Flood and Erosion Damage
- **FEMA 102**
Floodproofing Non-Residential Structures

Recommended for Architects and Engineers —

- **FEMA 259**
Engineering Principles and Practices for Retrofitting Flood Prone Residential Buildings

State and local representatives of emergency management, emergency services, floodplain management, building code, and planning and zoning agencies may have copies of FEMA 312 for immediate distribution.



Elevation



Wet Floodproofing



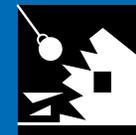
Relocation



Dry Floodproofing



Levees and Floodwalls



Demolition

Homeowner's Guide to Retrofitting

Six Ways To Protect Your House From Flooding



Federal Emergency Management Agency

Mitigation Directorate
Washington, DC 20472
www.fema.gov



What Is "Retrofitting"?

Retrofitting means making changes to an existing building to protect it from flooding or other hazards such as high winds and earthquakes. FEMA publication 312, *Homeowner's Guide to Retrofitting: Six Ways To Protect Your House From Flooding*, provides information that will help you decide whether your house is a candidate for retrofitting.

The guide helps by describing six retrofitting methods that protect your house from flooding.



Elevation is raising your house so that the lowest floor is above the flood level. This is the most common way to avoid flood damage.



Wet floodproofing makes uninhabited parts of your house resistant to flood damage when water is allowed to enter during flooding.



Relocation means moving your house to higher ground where the exposure to flooding is eliminated altogether.



Dry floodproofing is sealing your house to prevent flood waters from entering.

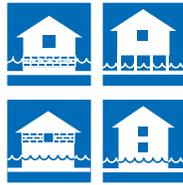


Levee and floodwall protection means constructing barriers to prevent flood waters from entering your house.

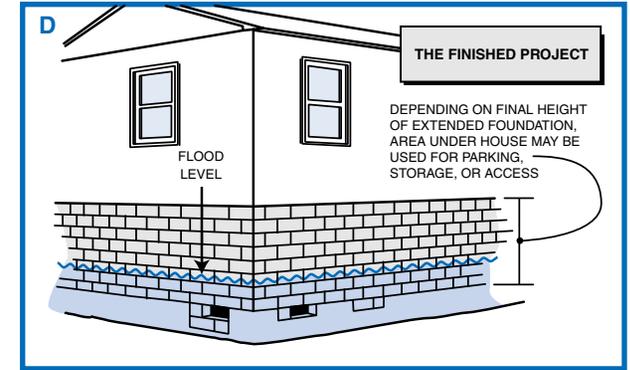
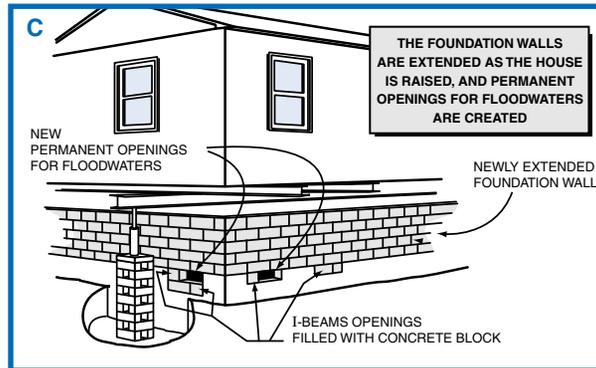
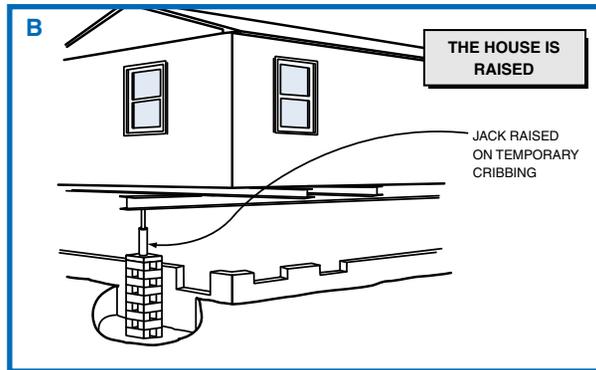
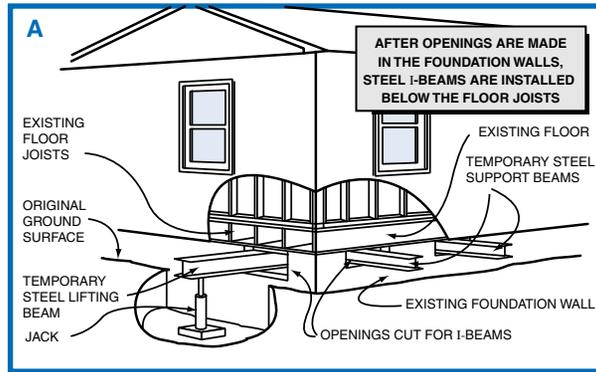


Demolition means razing your house and rebuilding properly on the same property or buying a house elsewhere.

The guide uses photographs and illustrations to help explain how each of the six retrofitting methods works.



For example, this series of figures from the guide shows how a house on a basement or crawlspace foundation can be elevated above the flood level on extended foundation walls.



The Next Step

Whether or not your house has been damaged by flooding, contact your local floodplain administrator or building official before retrofitting. This contact is the critical next step in reducing your potential flood losses. Local officials know the retrofitting methods that meet state and local government requirements.

Financial Assistance

The guide provides information on government and non-government financial assistance that can help homeowners with retrofitting projects. Financial assistance means loans, grants, and insurance payments. The assistance goes to individual property owners, communities, and states.

For example, under FEMA's National Flood Insurance Program, a policy holder may qualify for Increased Cost of Compliance (ICC) coverage. If your house is substantially damaged by flooding, ICC coverage may help pay for some types of retrofitting. Other programs, such as the Hazard Mitigation Grant Program and the Flood Mitigation Assistance Program are designed to help financially. The guide describes many government and non-government programs, and it explains how you might qualify for assistance.



FEMA

Protecting Your Business From Flooding

ARE YOU AT RISK?

If you aren't sure whether your business is at risk from flooding, check with your local floodplain manager, building official, city engineer, or planning and zoning administrator. They can tell you whether you are in a flood hazard area, and they also can tell you how to protect your business from flooding.

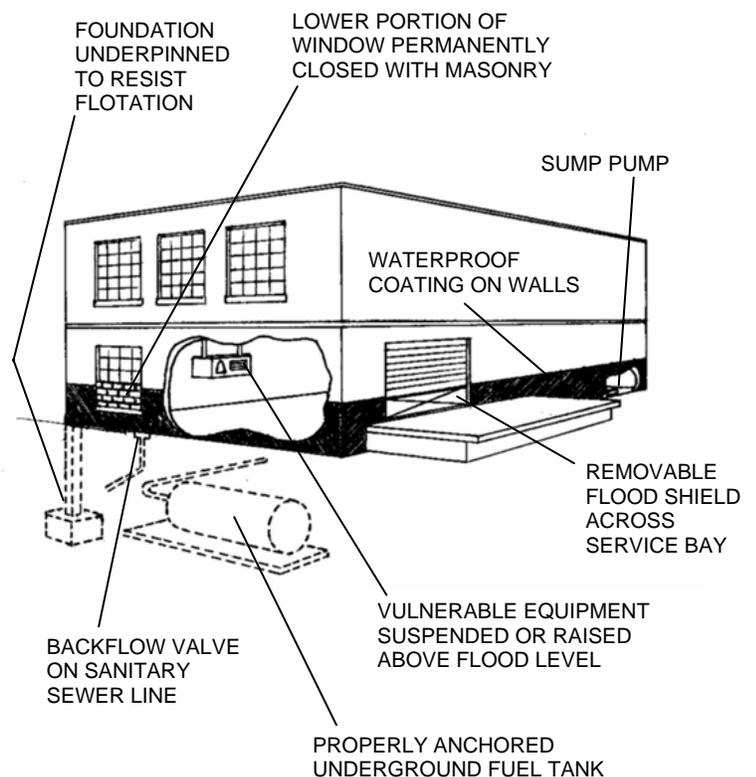
WHAT YOU CAN DO

Protecting your business from flooding can involve a variety of actions, from inspecting and maintaining your buildings to installing protective devices. Most of these actions, especially those that affect the structure of your buildings or their utility systems, should be carried out by qualified maintenance staff or professional contractors licensed to work in your state, county, or city. One example of flood protection is using dry floodproofing techniques to protect buildings in flood hazard areas.

DRY FLOODPROOF YOUR BUILDING

One way to protect a building and its contents from flood damage is to seal the building so that flood waters cannot enter. This method, referred to as "dry floodproofing," encompasses a variety of measures (some of which are covered by separate fact sheets – see back of this sheet):

- applying a waterproof coating or membrane to the exterior walls of the building
- installing watertight shields over doors, windows, and other openings
- anchoring the building as necessary so that it can resist floatation
- installing backflow valves in sanitary and storm sewer lines
- raising utility system components, machinery, and other pieces of equipment so that they are above the flood level
- anchoring fuel tanks and other storage tanks to prevent floatation
- installing a sump pump and foundation drain system
- strengthening walls so that they can withstand the pressures of flood waters and the impacts of floodborne debris



Protecting Your Business From Flooding

Dry Floodproof Your Building

TIPS

Keep these points in mind when you dry floodproof a building:

- ✓ Dry floodproofing is appropriate primarily for slab-on-grade buildings with concrete or solid masonry walls. Concrete and masonry are easier to seal, more resistant to flood damage, and stronger than other conventional construction materials.
- ✓ If you dry floodproof a “substantially damaged” or “substantially improved” building (as defined by the National Flood Insurance Program regulations) or a newly constructed building, and if the building’s lowest floor (including any basement) is below the Base Flood Elevation (BFE) shown on the Flood Insurance Rate Map (FIRM) for your community, your dry floodproofing must be certified as providing protection from the BFE. To obtain this certification, you must floodproof your building to a height at least 1 foot above the BFE. Check with your local floodplain manager or building official for more information.
- ✓ The height of your dry floodproofing should not exceed 3 feet. The pressures exerted by deeper water can cause walls to buckle or collapse. Before you use dry floodproofing to protect against greater flood depths, have a structural engineer evaluate the strength of your walls.
- ✓ If your dry floodproofing measures require human intervention, such as placing shields over doors and windows before flood waters arrive, you should have an operations and maintenance plan that describes all the actions that must be taken and lists the persons who are responsible. It must also include a schedule of periodic maintenance that states how often the dry floodproofing measures will be inspected and who will perform the inspections.

ESTIMATED COST

The cost of individual dry floodproofing measures will vary with the size, condition, and use of your building; the dry floodproofing height; and the extent to which you use contractors and engineers.

OTHER SOURCES OF INFORMATION

Install Sewer Backflow Valves, Protecting Your Property from Flooding, FEMA Hazard Mitigation Fact Sheet, 1998

Anchor Fuel Tanks, Protecting Your Property from Flooding, FEMA Hazard Mitigation Fact Sheet, 1998

Non-Residential Floodproofing – Requirements and Certification for Buildings Located in Special Flood Hazard Areas, FEMA Technical Bulletin 3-93, April 1993

Floodproofing Non-Residential Structures, FEMA 102, 1986

To obtain copies of FEMA documents, call FEMA Publications at 1-800-480-2520. Information is also available on the World Wide Web at <http://www.fema.gov>.



ARE YOU AT RISK?

If you aren't sure whether your house is at risk from flooding, check with your local floodplain manager, building official, city engineer, or planning and zoning administrator. They can tell you whether you are in a flood hazard area. Also, they usually can tell you how to protect yourself and your house and property from flooding.

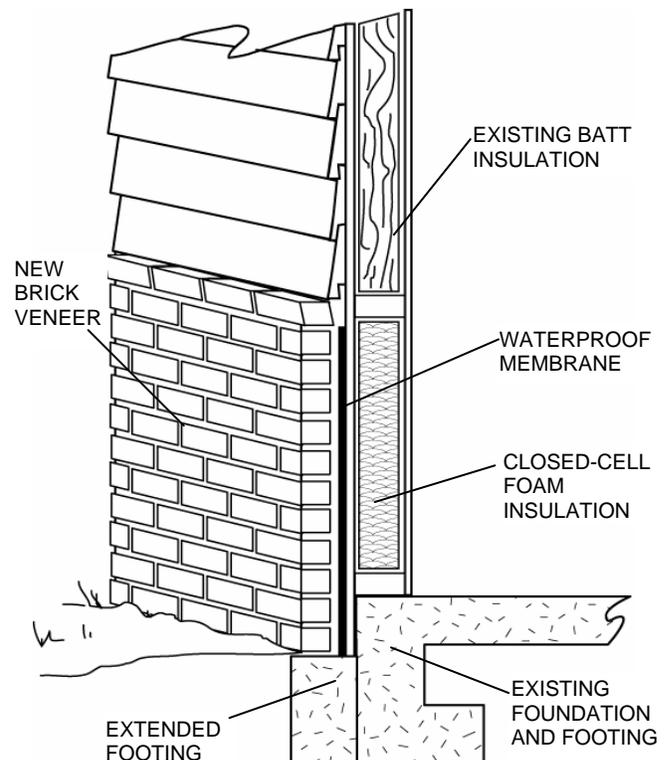
WHAT YOU CAN DO

Flood protection can involve a variety of changes to your house and property – changes that can vary in complexity and cost. You may be able to make some types of changes yourself; however, complicated or large-scale changes and those that affect the structure of your house or its electrical wiring and plumbing should be carried out only by a professional contractor licensed to work in your state, county, or city. One example of flood protection is adding a waterproof veneer to the exterior walls of your house. This is something that only a licensed contractor should do.

ADD WATERPROOF VENEER TO EXTERIOR WALLS

Even in areas where flood waters are less than 2 feet deep, a house can be severely damaged if water reaches the interior. The damage to walls and floors can be expensive to repair, and the house may be uninhabitable while repairs are underway.

One way to protect a house from shallow flooding is to add a waterproof veneer to the exterior walls and seal all openings, including doors, to prevent the entry of water. As shown in the figure, the veneer can consist of a layer of brick backed by a waterproof membrane. Before the veneer is applied, the siding is removed and replaced with exterior grade plywood sheathing. If necessary, the existing foundation footing is extended to support the brick. Also, because the wall will be exposed to flood water, changes are made to the interior walls as well so that they will resist moisture damage. In the area below the flood level, standard batt insulation is replaced with washable closed-cell foam insulation, and any wood blocking added inside the wall cavity is made of exterior grade lumber.



Protecting Your Property From Flooding

Add Waterproof Veneer to Exterior Walls

TIPS

Keep these points in mind if you plan to have a waterproof veneer added to the exterior walls of your house:

- ✓ Adding a waterproof veneer is appropriate in areas where the flood depth is less than 2 feet. When flood depths exceed 2 feet, the pressure on waterproofed walls increases greatly, usually beyond the strength of the walls. If greater flood depths are expected, consult with a licensed civil or structural engineer before using this method.
- ✓ Changes to the foundation of your house must be done by a licensed contractor, who will ensure that the work is done correctly and according to all applicable codes. This is important for your safety.
- ✓ If your house is being remodeled or repaired, consider having the veneer added as part of the remodeling or repair work. It will probably be cheaper to combine these projects than to carry them out separately.
- ✓ If your house has brick walls, you can still use this method. The new brick veneer and waterproof membrane are added over the existing brick.
- ✓ If your house is flooded by groundwater entering through the floor, this method will not be effective.

ESTIMATED COST

If you have a contractor add a waterproof brick veneer to your house, you can expect to pay about \$10 per square foot of exterior wall. For example, a 3-foot-high brick veneer on a house measuring 60 feet by 30 feet would cover about 540 square feet and would cost about \$5,400. This figure does not include the cost of sealing doors and other openings or extending the foundation.

OTHER SOURCES OF INFORMATION

Protecting Your Home from Flooding, FEMA, 1994

Repairing Your Flooded Home, FEMA-234, 1992

Flood Emergency and Residential Repair Handbook, FIA-13, 1986

Retrofitting Flood-Prone Residential Structures, FEMA-114, 1986

To obtain copies of these and other FEMA documents, call FEMA Publications at 1-800-480-2520. Information is also available on the World Wide Web at <http://www.fema.gov>.



ARE YOU AT RISK?

If you aren't sure whether your house is at risk from flooding, check with your local floodplain manager, building official, city engineer, or planning and zoning administrator. They can tell you whether you are in a flood hazard area. Also, they usually can tell you how to protect yourself and your house and property from flooding.

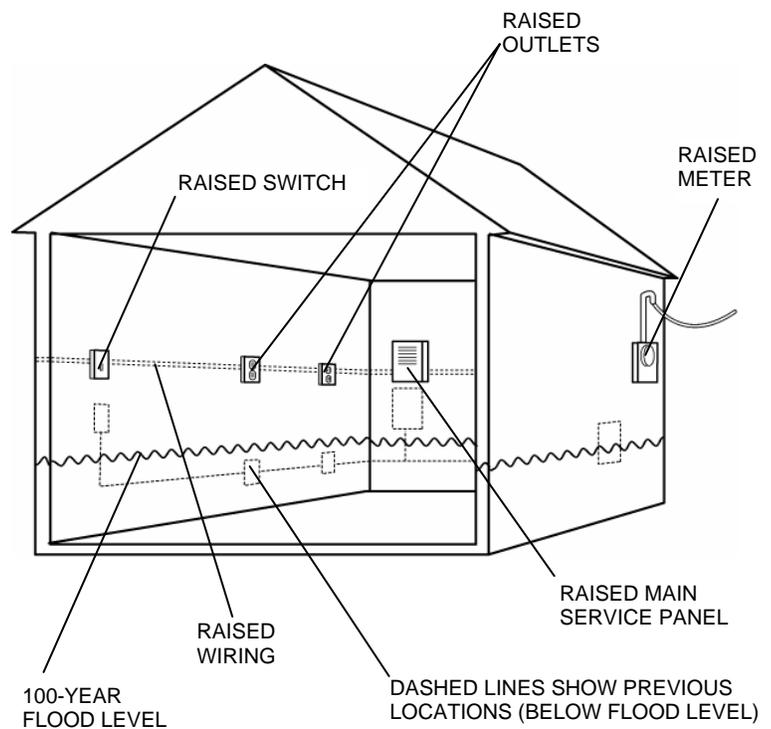
WHAT YOU CAN DO

Flood protection can involve a variety of changes to your house and property – changes that can vary in complexity and cost. You may be able to make some types of changes yourself; however, complicated or large-scale changes and those that affect the structure of your house or its electrical wiring and plumbing should be carried out only by a professional contractor licensed to work in your state, county, or city. One example of flood protection is raising the components of your electrical system above the level of the 100-year flood. This is something that only a licensed contractor should do.

RAISE ELECTRICAL SYSTEM COMPONENTS

Electrical system components, including service panels (fuse and circuit breaker boxes), meters, switches, and outlets, are easily damaged by flood water. If they are inundated for even short periods, they will probably have to be replaced. Another serious problem is the potential for fires caused by short circuits in flooded systems. Raising electrical system components helps you avoid those problems. Also, having an undamaged, operating electrical system after a flood will help you clean up, make repairs, and return to your home with fewer delays.

As shown in the figure, all components of the electrical system, including the wiring, should be raised at least 1 foot above the 100-year flood level. In an existing house, this work will require the removal of some interior wall sheathing (drywall, for example). If you are repairing a flood-damaged house or building a new house, elevating the electrical system will be easier.



Protecting Your Property From Flooding

Raise Electrical System Components

TIPS

Keep these points in mind when you have your electrical system components raised:

- ✓ Electrical system modifications must be done by a licensed contractor, who will ensure that the work is done correctly and according to all applicable codes. This is important for your safety.
- ✓ Your contractor should check with the local power company about the maximum height that the electric meter can be raised.
- ✓ If your house is equipped with an old-style fuse box or low-amperage service, you may want to consider upgrading to a modern circuit breaker system and higher-amperage service, especially if you have large appliances or other electrical equipment that draws a lot of power.

ESTIMATED COST

Raising the electrical service panel, meter, and all of the outlets, switches, and wiring in a 1,000-square-foot, single-floor house will cost about \$1,500 to \$2,000. If this work is performed during the repair of a damaged house or construction of a new house, the cost may be much lower.

OTHER SOURCES OF INFORMATION

Protecting Your Home from Flooding, FEMA, 1994

Repairing Your Flooded Home, FEMA-234, 1992

Flood Emergency and Residential Repair Handbook, FIA-13, 1986

Retrofitting Flood-Prone Residential Structures, FEMA-114, 1986

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FEMA

Protecting Your Property From Flooding

ARE YOU AT RISK?

If you aren't sure whether your house is at risk from flooding, check with your local floodplain manager, building official, city engineer, or planning and zoning administrator. They can tell you whether you are in a flood hazard area. Also, they usually can tell you how to protect yourself and your house and property from flooding.

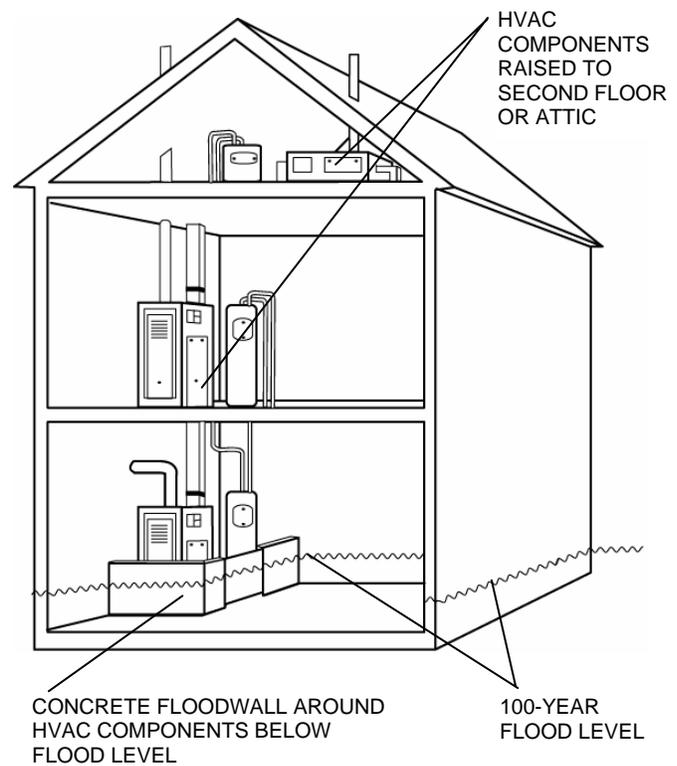
WHAT YOU CAN DO

Flood protection can involve a variety of changes to your house and property – changes that can vary in complexity and cost. You may be able to make some types of changes yourself; however, complicated or large-scale changes and those that affect the structure of your house or its electrical wiring and plumbing should be carried out only by a professional contractor licensed to work in your state, county, or city. One example of flood protection is raising the heating, ventilating, and cooling equipment in your house so that it is above the flood level, or surrounding it with a flood wall. These are things that only a licensed contractor should do.

RAISE OR FLOODPROOF HVAC EQUIPMENT

Heating, ventilating, and cooling (HVAC) equipment, such as a furnace or hot water heater, can be damaged extensively if it is inundated by flood waters. The amount of damage will depend partly on the depth of flooding and the amount of time the equipment remains under water. Often, the damage is so great that the only solution is replacement.

In floodprone houses, a good way to protect HVAC equipment is to move it from the basement or lower level of the house to an upper floor or even to the attic. A less desirable method is to leave the equipment where it is and build a concrete or masonry block floodwall around it. Both of these methods require the skills of a professional contractor. Relocation can involve plumbing and electrical changes, and floodwalls must be adequately designed and constructed so that they are strong enough and high enough to provide the necessary level of protection.



Protecting Your Property From Flooding

Raise or Floodproof HVAC Equipment

TIPS

Keep these points in mind when you have your HVAC equipment raised or floodproofed:

- ✓ Changes to the plumbing, electrical system, and ventilating ductwork in your house must be done by a licensed contractor, who will ensure that the work is done correctly and according to all applicable codes. This is important for your safety.
- ✓ If you are having your existing furnace or hot water heater repaired or replaced, consider having it relocated at the same time. It will probably be cheaper to combine these projects than to carry them out at different times.
- ✓ Similarly, if you have decided to raise your HVAC equipment, consider upgrading to a more energy-efficient unit at the same time. Upgrading can not only save you money on your heating and cooling bills, it may also make you eligible for a rebate from your utility companies.
- ✓ If you decide to protect your HVAC equipment with a floodwall, remember that you will need enough space in the enclosed area for system repairs and routine maintenance. Also, depending on its height, the wall may have to be equipped with an opening that provides access to the enclosed area. Any opening will have to be equipped with a gate that can be closed to prevent flood waters from entering.

ESTIMATED COST

Having your furnace and hot water heater moved to a higher floor or to the attic will cost about \$ 1,500. The cost of a floodwall will depend partly on its height and length. A 3-foot-high wall with a perimeter length of 35 feet would cost about \$1,000.

OTHER SOURCES OF INFORMATION

Protecting Your Home from Flooding, FEMA, 1994

Repairing Your Flooded Home, FEMA-234, 1992

Flood Emergency and Residential Repair Handbook, FIA-13, 1986

Retrofitting Flood-Prone Residential Structures, FEMA-114, 1986

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ARE YOU AT RISK?

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WHAT YOU CAN DO

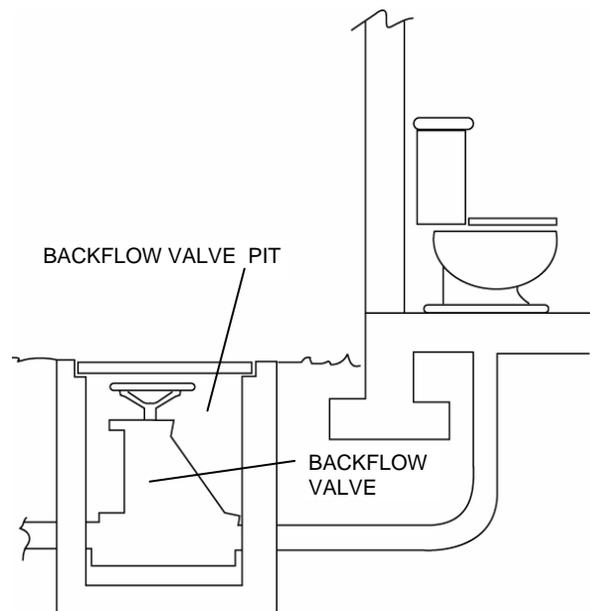
Flood protection can involve a variety of changes to your house and property – changes that can vary in complexity and cost. You may be able to make some types of changes yourself; however, complicated or large-scale changes and those that affect the structure of your house or its electrical wiring and plumbing should be carried out only by a professional contractor licensed to work in your state, county, or city. One example of flood protection is installing a backflow valve to prevent sewage from backing up into your house. This is something that only a licensed plumber or contractor should do.

INSTALL SEWER BACKFLOW VALVES

In some floodprone areas, flooding can cause sewage from sanitary sewer lines to back up into houses through drain pipes. These backups not only cause damage that is difficult to repair, but also create health hazards.

A good way to protect your house from sewage backups is to install backflow valves, which are designed to block drain pipes temporarily and prevent flow into the house. Backflow valves are available in a variety of designs that range from the simple to the complex. The figure shows a gate valve, one of the more complex designs. It provides a strong seal, but must be operated by hand. So the effectiveness of a gate valve will depend on how much warning you have of impending flooding. Among the simpler valves are a flap or check valves, which open to allow flow out of the house but close when the flow reverses. These valves operate automatically but do not provide as strong a seal as a gate valve.

TYPICAL INSTALLATION OF AN EXTERIOR BACKFLOW VALVE



← NORMAL DIRECTION OF FLOW (VALVE PREVENTS FLOW IN REVERSE DIRECTION)

Protecting Your Property From Flooding

Install Sewer Backflow Valves

TIPS

Keep these points in mind if you have backflow valves installed:

- ✓ Changes to the plumbing in your house must be done by a licensed plumber or contractor, who will ensure that the work is done correctly and according to all applicable codes. This is important for your safety.
- ✓ Some valves incorporate the advantages of both flap and gate valves into a single design. Your plumber or contractor can advise you on the relative advantages and disadvantages of the various types of backflow valves.
- ✓ Valves should be installed on all pipes that leave the house or that are connected to equipment that is below the potential flood level. So valves may be needed on washing machine drain lines, laundry sinks, fuel oil lines, rain downspouts, and sump pumps, as well as sewer/septic connections.
- ✓ If you have a sump pump, it may be connected to underground drain lines, which may be difficult to seal off.

ESTIMATED COST

Having a plumber or contractor install one backflow valve will cost you about \$525 for a combined gate/flap valve or about \$375 for a flap valve. These figures include the cost of excavation and backfilling.

OTHER SOURCES OF INFORMATION

Protecting Your Home from Flooding, FEMA, 1994

Repairing Your Flooded Home, FEMA-234, 1992

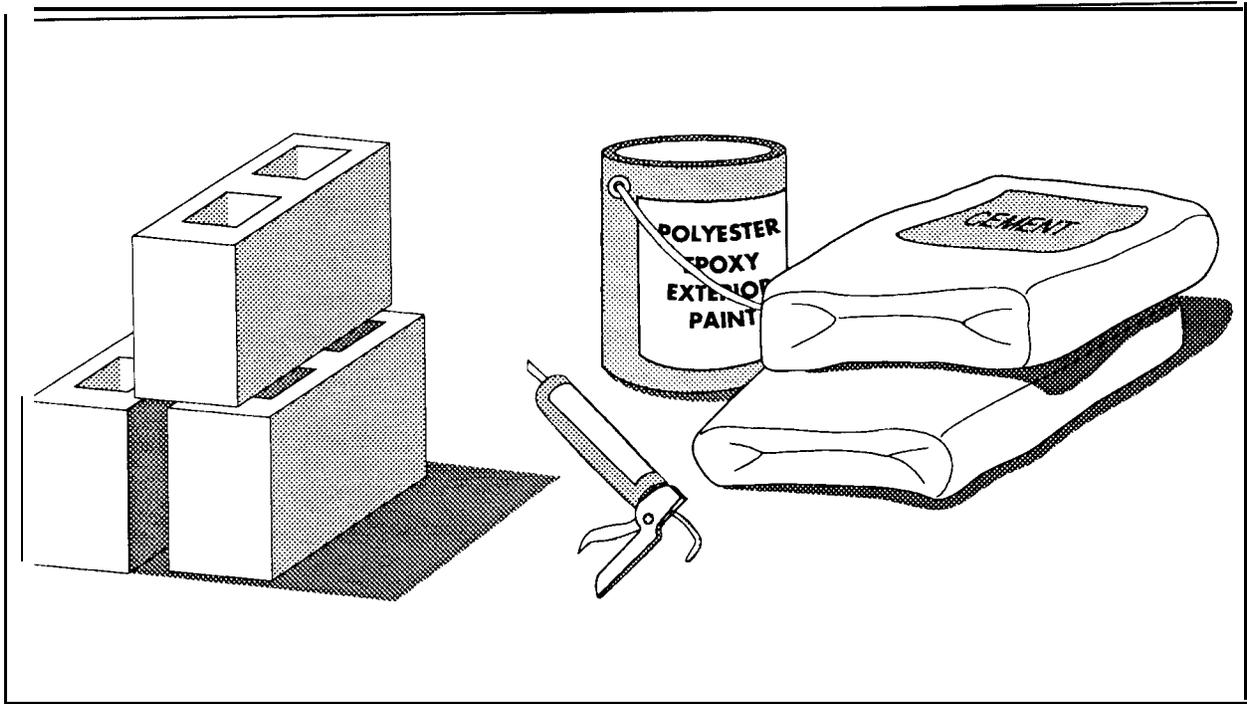
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Flood-Resistant Materials Requirements
for Buildings Located in Special Flood Hazard Areas
in accordance with the
National Flood Insurance Program



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.

Key Word/Subject	Page
Breakaway wall materials in V zones, made of flood-resistant materials	12
Flood-resistant flooring materials	4
Flood-resistant material, definition of	1
Flood-resistant materials, classifications, use of	2
Flood-resistant wall and ceiling materials	7
Latticework in V zones, made of flood-resistant materials	12
U.S. Army Corps of Engineers "Flood Proofing Regulations"	2

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."

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... 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 V 1 -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		
N F I P	Class	Class Description
A C C E P T A B L E	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.
U N A C C E P T A B L E	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		●			
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		●			
Vinyl tile or sheets (coated on cork or wood product backings)					●
Vinyl-asbestos tile (semi-flexible vinyl) ¹					●
With asphaltic adhesives		●			
Wood flooring or underlay merits					●
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')				●	
Keene's cement or 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 V1-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.

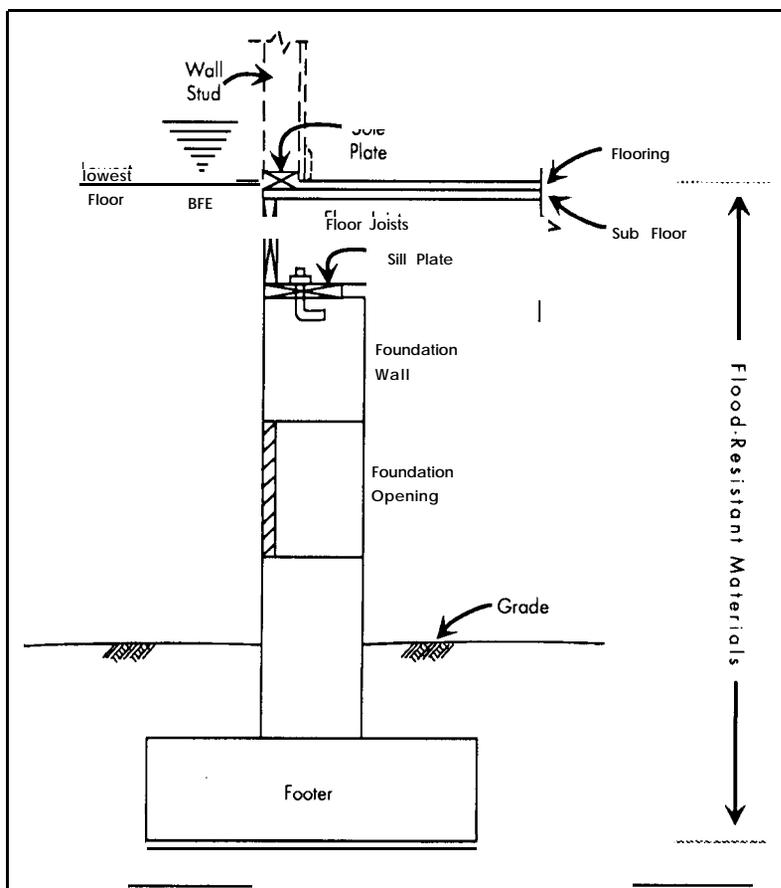


Figure 1. Building Elevated on Solid Foundation Walls Meeting the Minimum NFIP Requirements for Zones A, AE, A1-A30, AR, AO, and AH

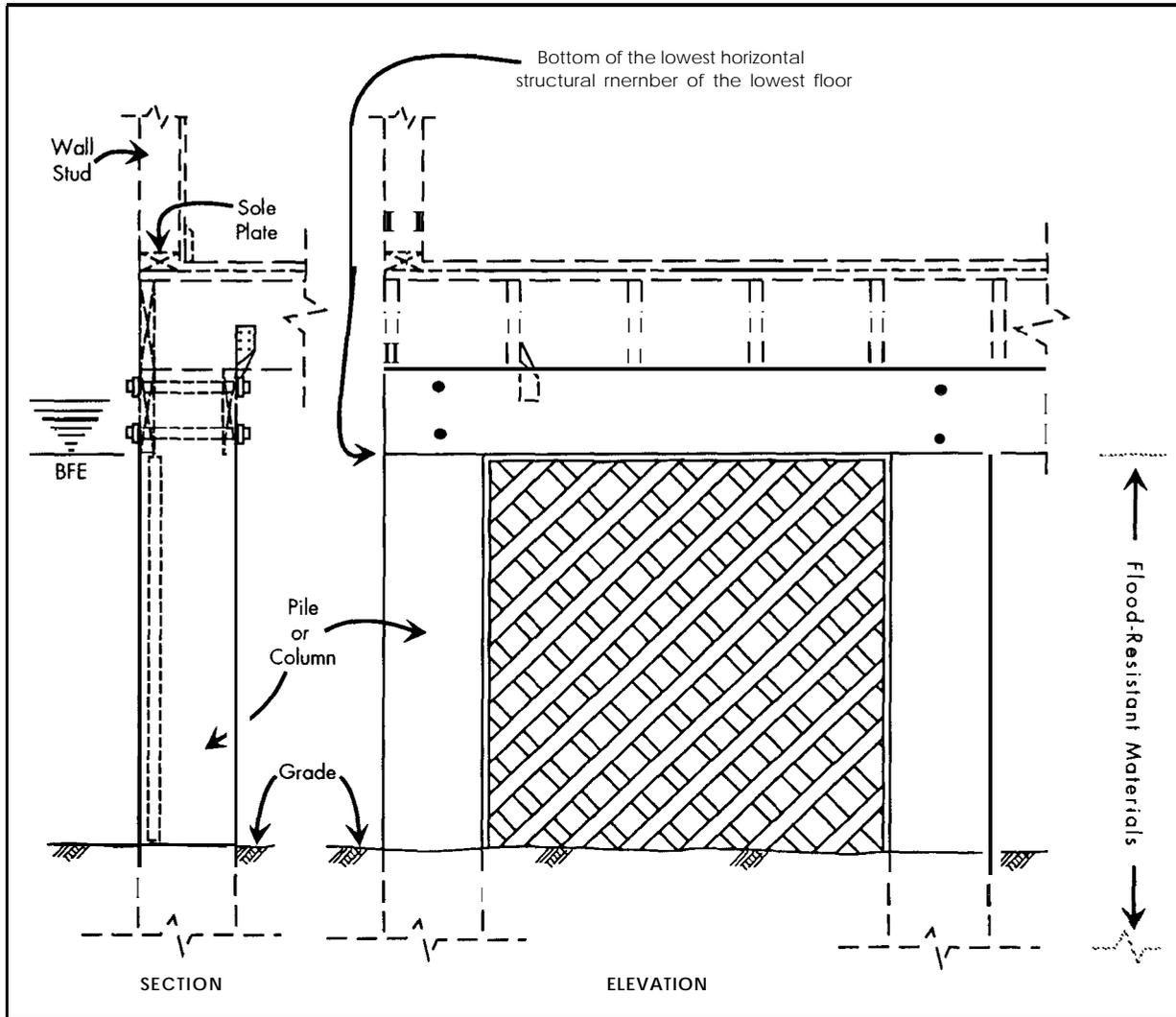


Figure 2. Flood-Resistant Material Requirements for Buildings Elevated in Accordance with NFIP Requirements for Zones V, VE, and V1 -V30

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.

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, AO, 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.