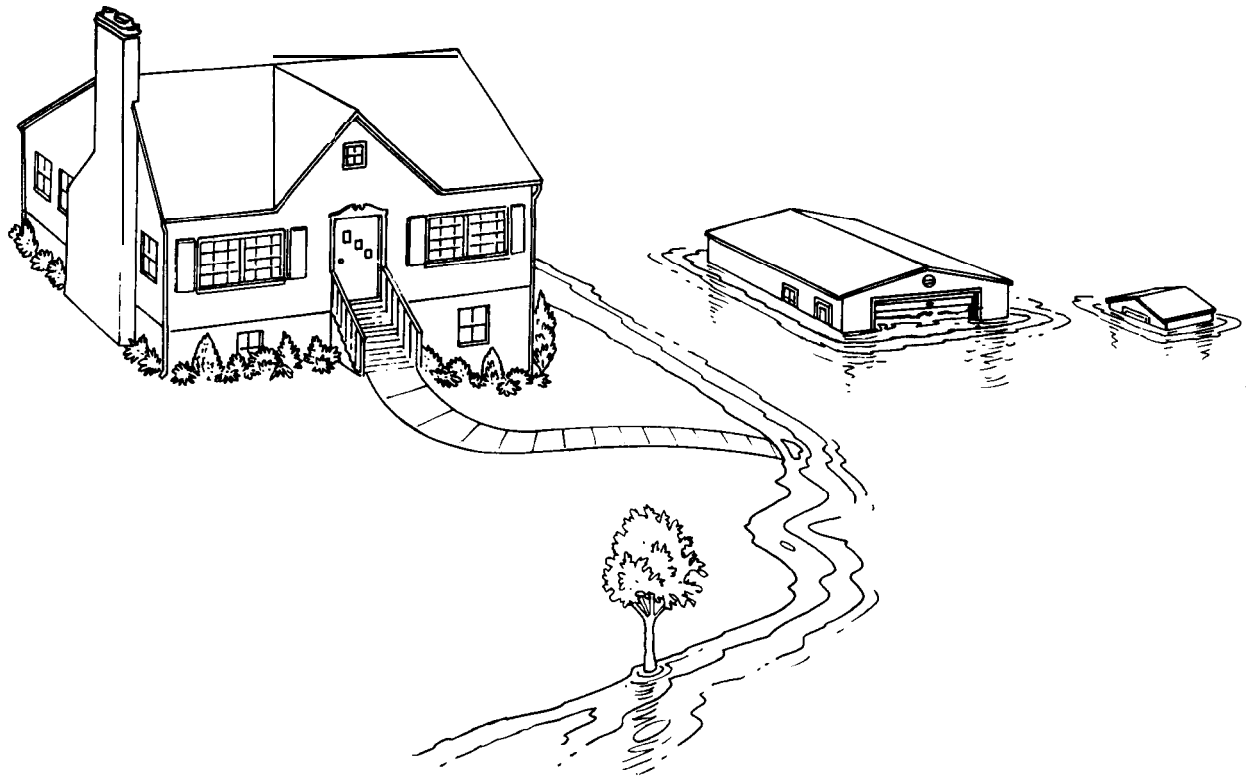


**Wet Floodproofing Requirements
for Structures Located in Special Flood Hazard Areas
in accordance with the
National Flood Insurance Program**



FEDERAL EMERGENCY MANAGEMENT AGENCY
MITIGATION DIRECTORATE
FEDERAL INSURANCE ADMINISTRATION

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Key Word/Subject Index:

This index allows the user to 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.

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TECHNICAL BULLETIN 7-93

Wet Floodproofing Requirements for Buildings Located in Special Flood Hazard Areas in Accordance with the National Flood Insurance Program

INTRODUCTION

This bulletin describes planning, design, and construction requirements for wet floodproofing certain types of structures and their uses under the National Flood Insurance Program (NFIP). The basic characteristic that distinguishes wet floodproofing from dry floodproofing is the internal flooding of a structure as opposed to providing essentially watertight protection. Specifically, wet floodproofing can be defined as:

Permanent or contingent measures applied to a structure and/or its contents that prevent or provide resistance to damage from flooding by allowing flood waters to enter the structure.

Flooding of a structure's interior is intended to counteract hydrostatic pressure on the walls, surfaces, and supports of the structure by equalizing interior and exterior water levels during a flood. Inundation also reduces the danger of buoyancy from hydrostatic uplift forces. Such measures may require alteration of a structure's design and construction, use of flood-resistant materials, adjustment of building operation and maintenance procedure, relocation and treatment of equipment and contents, and emergency preparedness for actions that require human intervention.

In accordance with the NFIP, Wet Floodproofing is allowed in only limited situations

Application of wet floodproofing as a flood protection technique under the NFIP is limited to specific situations in A Zones (including A, AE, A1-30, AH, AO, AR zones). For certain uses and types of structures described in this bulletin, communities may allow wet floodproofing only through the issuance of a variance from certain floodplain management requirements. The situations and conditions in which a community may allow wet floodproofing are described in detail in the section entitled Applicability.

For structures in V zones (includes V, VE, V1-30 zones), more stringent design and construction requirements have been established for the portion of a structure below the Base Flood Elevation (BFE). For information on V-zone design and construction requirements, refer to the NFIP regulations under 44 CFR Section 60.3, the Technical Bulletin series, and FEMA's "Coastal Construction Manual" (FEMA 55).

APPLICABILITY

New Construction and Substantial Improvements of Residential and Non-Residential structures

An important objective of the NFIP is to protect structures constructed in floodplains from flood-induced damage. In support of this objective, the NFIP regulations include building design and construction criteria that apply to new construction and substantial improvements (including structures which have incurred substantial damage) of existing structures in Special Flood Hazard Areas (SFHA). According to these criteria, residential structures in A zones must be constructed with their lowest floors elevated to or above the BFE. Non-residential structures constructed in A zones must either have their lowest floors elevated to or above the BFE or be dry floodproofed (made watertight) to or above the BFE. Measures to accomplish dry floodproofing of non-residential structures must not only provide watertight protection but also must be designed to withstand hydrostatic, hydrodynamic, and impact forces produced by flooding. The intent is to provide complete protection at least up to the floodproofing design level which must, at a minimum, be at the BFE.

Note: To receive a flood insurance rate based on 100 year flood protection, the structure must be dry floodproofed to an elevation at least 1 foot above the BFE. (i.e. 1 foot of freeboard)

In accordance with the NFIP, there are limited enclosed areas within newly constructed and substantially improved residential and non-residential structures where the community may allow wet floodproofing without a variance as a flood protection technique. These are limited to:

Enclosed areas below the BFE that are used solely for parking, building access, or limited storage. New construction and the substantial improvement of residential and non-residential structures whose lowest floors have been constructed at or above the BFE may be constructed with enclosed areas below the BFE. These areas must; (1) be used solely for parking, building access, or limited storage, (2) be designed to allow for the automatic entry and exit of flood waters through the use of openings, and (3) be constructed of flood resistant materials.

Attached garages. A garage attached to a residential structure, constructed with the garage floor slab below the BFE, must be designed to allow for the automatic entry of flood waters. Openings are required in the exterior walls of the garage or in the garage doors. In addition to allowing the automatic entry of flood waters, the areas of the garage below the BFE must be constructed with flood resistant materials. Garages attached to non-residential structures must meet the aforementioned requirements or be dry floodproofed. For guidance on below-grade parking areas refer to Technical Bulletin 6, "Below-Grade Parking Requirements".

Wall Finishes: The exterior cladding of a structure subject to flooding should be nonporous, resistant to chemical corrosion or debris deposits, and conducive to easy cleaning. Relatively impervious cladding such as hard brick, pressure-treated wood, metal, and concrete are some of the acceptable materials.

As with exterior surfaces, interior cladding should be easy to clean and not susceptible to damage from inundation. Materials that are solid and relatively impervious such as concrete, hard brick, plastic, and pressure-treated wood, are most suitable.

Metal-clad structures such as those found in many agricultural operations should be constructed of corrosion-resistant materials. Framing and cladding must meet the same flood-resistant requirements as all other materials. Metal fasteners used with metal panel cladding systems are susceptible to corrosion and should be a corrosion-resistant type, such as hot dipped galvanized or stainless steel.

Where interior wall finishes are present, they shall meet the same flood resistant standards as all other materials located below the BFE.

Floors: subfloor systems in wet floodproofed structures are normally concrete or gravel. Materials that are attached to the concrete subfloor, such as tile, paint, or wood, and the attachment mechanism (adhesives, nails, screws, etc.) that secures the finish material to the subfloor structure, should be able to withstand inundation associated with a base flood event without damage or alteration.

Ceilings and Roofs. When it is anticipated that flood levels will come in contact with the ceiling, flood resistant material requirements apply for ceiling materials and attachment mechanisms (hangers, adhesives, screws). To protect the ceilings and roofs from the pressure of entrapped air or water, pressure relief vents should be used. Even in those cases where flood waters are expected to be below ceiling levels, ceilings materials including attachment mechanisms should be able to withstand prolonged exposure to moisture and humidity associated with flood and post-flood conditions.

Building Envelope Openings. Openings in a structure's floors, walls, ceilings, and roofs are often enclosed by architectural components such doors, windows, louvers, vents, skylights, etc. These components include fasteners, gaskets, seals, glazing, locks, and finishes. Again, even those items not expected to be inundated must be resistant to humidity and moisture damage. NFIP flood resistant material requirements apply to all architectural components that are to be exposed to flooding or resulting excessive moisture. All materials shall be capable of resisting damage associated with a base flood event. Door systems include frame, hinges, threshold, and panels. Since solid wood, wood laminate, or hollow core wood door panels may warp, swell and/or rot, sealed metals are preferable.

Windows are susceptible to damage from debris carried by floodwater. The use of glass blocks, sealed unbreakable panes, and wire-reinforced glass will resist flood

damage. Protective screens may also be successful in preventing debris impact. The use of tempered glass or impact-resistant plastic (acrylic or polycarbonate) is recommended for large window areas of 20 square feet or more.

Protection of Mechanical and Electrical Svstems: While the NFIP regulations do not prohibit the placement of mechanical and electrical components below the BFE, they are required to be designed and/or located so as to prevent flood water from entering or accumulating within them. The preferred method of meeting this requirement is to locate flood-threatened components above the expected flood level. Other options that may meet the NFIP requirements for electrical systems that can not be elevated involve emergency operation and maintenance procedures, including disconnecting and elevating or relocating electrically controlled equipment, installing elevated control panels for cutoff of electricity, or enclosing service equipment in waterproof utility enclosure areas. Mechanical systems that must be located below the design flood level should be provided with waterproofed enclosures to protect bearings, seals, gears clutches, valves, or controls that will not withstand immersion, silt damage, or water pressure.

Electrical Svstem. Electricity is a primary source of energy for many vital building operations. Wet floodproofing an electrical system primarily involves preventing vulnerable components from coming in contact with water. Elevation of all electrical components except the minimum necessary to operate the structure (minimal number of light switches and receptacles) is required. Where switches and receptacles must be located below the BFE, sealed or capped moisture-resistant components are required. Ground Fault Circuit Interrupters shall be utilized for all electrical circuits that serve areas below the BFE. Key system components for which elevation above floodwater is desirable include transformers, switchboards, and branch panels. A possible alternative may be to enclose these elements with a waterproof protective barrier. In circumstances which dictate that it is not practicable to safely maintain power during inundation, complete cutoff must be utilized. This of course presents the need for inspections and actions to ensure complete drying of electrical components prior to power restoration.

Electrical service provided to a structure from poles or other overhead sources should enter the structure at a point above the expected flood level. Underground service cables may be feasible provided that they are waterproofed and not exposed to direct contact with flood water.

Heating and Ventilating In general, heating and ventilating equipment is not designed to withstand inundation and is prone to severe floodwater damage. Thus, elevating is recommended to preclude inundation of system components. In situations where elevation is not practical, quick release/disconnect mechanisms should be incorporated into the design. One example is fan motor components for groin bin aeration systems which are configured to be easily removed and relocated prior to flooding.

Liquid Storage Containers Liquid and gas containers are subject to extreme hydrostatic pressure during inundation. Where possible, such containers should be elevated to or above the BFE or located outside the floodplain. If a newly constructed container will be subject to inundation, it is required under the NFIP to be anchored to withstand a buoyant force acting upon it in its empty state. Containers should have watertight fill caps and vents that extend above the expected flood level, and should be labelled according to contents. Labeling will allow emergency personnel to identify the contents in the event the tanks breaks loose and floats away. It is important to note that underground tanks are also subject to uplift forces. Empty tanks, both above and below ground, should be filled with potable water prior to the arrival of floodwater. The post-flood disposal of this possibly contaminated water must be in accordance with all applicable federal, state and local regulations.

Flood Resistant Materials

In accordance with the NFIP, all materials exposed to floodwater must be durable, resistant to flood forces, and retardant to deterioration caused by repeated exposure to flood water. Generally, these performance requirements result in masonry construction being the most suited to wet floodproofing in terms of damage resistance. In some cases wood or steel structures may be candidates, provided that the wood is pressure treated or naturally decay resistant and steel is galvanized or protected with rust-retardant paint. Detailed guidance is provided in Technical Bulletin #2 "Flood-Resistant Material Requirements."

Protection of Contents and Equipment

Isolation from Floodwater. Consideration should be given to preventing, to the maximum extent possible, the contact of floodwater with damage-susceptible items. This can be accomplished through relocation prior to flooding, elevation, or in-place protection of flood-damageable items.

Relocation: The most effective method of protection for equipment and contents is to relocate threatened items out of harm's way. The interior of the structure must be organized in a way that ensures easy access and facilitates relocation. Aisles, doors, and corridors shall be wide enough and equipment size should be evaluated to allow any planned relocation or removal. Where structures are used to store bulk materials, such as grain, provisions must be made for the orderly removal and relocation of the contents to an area outside the floodplain.

Elevation: Within the flood-prone structure, elevation of key items could be achieved through the use of existing or specially constructed platforms or pedestals. Contingent elevation can be accomplished by the use of hoists or some type of overhead suspension system. Elevation techniques can be applied to a wide range of objects--machinery, utility system components (particularly electrical equipment), fuel and storage containers, and contents.

In-Place Protection: Some items can be protected, in-place, through a variety of options. Protective waterproof enclosures may be feasible for items that are difficult to move or relocate. Anchors and tie-downs, shall be used where appropriate to prevent flotation and movement, especially in the case of storage containers. Depending on flood characteristics, such enclosures may not have to be inconveniently high or completely permanent. Low barriers or flood shields may supply the necessary protection. Also, steps or ramps can be incorporated into the design to further maintain easy access.

Protective coatings can be applied to equipment to reduce inundation damage. Petroleum based greases, hot dip plastics, spray or cold plastics can all be applied to oily surfaces. If they are applied to painted surfaces they must be non-migratory and not applied to threaded surfaces. Coatings can provide protection and enhance cleanup ease.

The use of “quick-disconnect” type plug and receptacle sets on standard electrical motors and other electrical connections provides several advantages. This allows for rapid shutdown, eliminates the need for an electrician, simplifies removal operations, and enables rapid reinstallation and restart. Similarly, motor-pump type units can be equipped with quick disconnect fittings on both suction and discharge lines in addition to electrical power lines. These actions also provide the added benefit of facilitating routine maintenance and relocation of equipment.

Mounting equipment and inventory on skids or pallets contributes greatly to contingent relocation, elevation, and removal actions using a fork lift. Large items that can be lifted from overhead should be permanently fitted with lifting bars or lugs. This eliminates time for rigging and benefits routine procedures. Any accessory items required, such as motor mount shims or necessary tools, should be stored nearby.

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 Mitigation Division 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 non-residential floodproofing:

1. "Answers to Questions About Substantially Damaged Buildings," FEMA, May 1991, FEMA-213.
2. "Commercial-Industrial Flood Audit," New England District, U.S. Army Corps of Engineers, n.d.
3. "Cooperative Flood Loss Reduction," A Technical Manual for Communities and Industries, Flood Loss Reduction Associates, 1981.
4. "Design Manual for Retrofitting Flood-Prone Residential Structures," FEMA, September 1986, FEMA-1 14.
5. "Floodproofing Non-Residential Structures," FEMA, May 1986, FEMA-102.
6. "Flood Proofing Regulations, U.S. Army Corps of Engineers," March 1992, EP 1165-2-314.
7. "Human Stability in a High Flood Hazard Zone," S.R. Abt, R.J. Whittlen, A. Taylor, and D.J. Love, Water Resource Bulletin, August 1989.
8. "Repairing Your Flooded Home," FEMA, August 1992, FEMA-234.
9. "Sealants, Part 1," John P. Cook, Progressive Architecture, December 1974.
10. "Sealants, Part 2," John P. Cook, Progressive Architecture, February 1975.

New Construction/Structure For floodplain management purposes, new construction means structures for which the start of construction commences on or after the effective date of a floodplain management regulation adopted by a community and includes all subsequent improvements to the structure. These structures are often referred to as “Post-FIRM” Structures.

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.

Wet Floodproofing Permanent or contingent measures applied to a structure and/or its contents that prevent or provide resistance to damage from flooding by allowing water to enter the structure.