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This chapter does not apply to substantially damaged or substantially improved buildings. See Section 2.4 for further information.

## 4.0 Introduction

Utilities in existing buildings can often be effectively protected from flood damage. The easiest and most practical time to undertake this effort is during a renovation or repair project. If the building has been substantially damaged and/or the building is being substantially improved, the National Flood Insurance Program (NFIP) requires that the building support utility systems be protected from flood damage to the criteria required for new construction as outlined in Chapter 3. However, in many circumstances, a building will suffer damage that does not result in the structure being substantially damaged. In those cases, the owner is provided with three basic options for repairing the building.



Although the NFIP does not require non-substantially improved buildings to meet the same criteria as those required of new and substantially improved buildings, every retrofitting project in flood-proofing should, to the greatest extent possible and practical, meet or even exceed the requirements of the NFIP.

- **Replace the system with a like system** – This option is typically the cheapest option, but provides no improved protection from future flood damage
- **Implement low-cost retrofits similar to those recommended in this chapter** – These options can cost more than replacement of the system with a like system, but for a minimal additional cost, large benefits may be realized especially when protecting from smaller future flooding events.
- **Mitigate future damage using the standards outlined in Chapter 3** – These options typically protect the system from future damage through elevation or protection of the system in place. This option is usually the most costly, but it can protect the owner from the inconvenience of repeated future flood damages.

Even where a retrofitting project is not required to meet the minimum NFIP standards for new and improved structures, it is still worth implementing measures that make an existing utility system more resistant to future flood damage.



For information on the determination of substantial damage, refer to Section 2.4.

If utilities are severely damaged, a structurally sound residence may be rendered uninhabitable due to unsafe or unsanitary conditions. As a result, moderately priced measures for protecting utilities are often considered cost effective by allowing the residence to remain habitable. For example, it is worth elevating an air conditioning or heat pump compressor to a higher level, even if the compressor still remains below the Design Flood Elevation (DFE); since it would at least be safe from lower-level floods.



### 4.1 Methods of Floodproofing Existing Utility Systems by Retrofitting

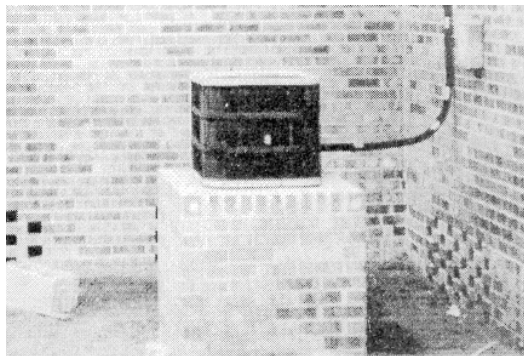
Retrofitting building support utility systems involves a combination of adjustments or additions to features of existing building support utility systems that are intended to eliminate or reduce the possibility of flood damage. Retrofitting measures include the following:

- **Elevation/Relocation** - The elevation of components of an existing building support utility system on a cantilevered platform, fill or foundation elements such as solid walls, piers, posts, columns, or piling is the most common type of component protection in shallow flooding areas. *Figure 4.1A* shows an air conditioning compressor elevated atop a pedestal. Elevation also includes relocation of components of an existing utility system to a higher location such as a higher floor of the building or to a utility building or platform that is located at a higher elevation.



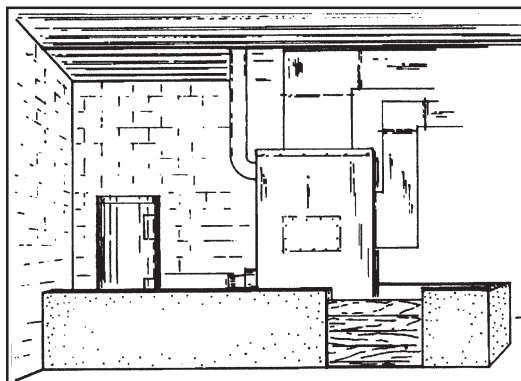
This chapter does not apply to substantially damaged or substantially improved buildings. See Section 2.4 for further information.

**Figure 4.1A:**  
Elevated air conditioning compressor



- **Component Protection** - Making utility components flood damage-resistant and water-resistant during periods of flooding within the structure. *Figure 4.1B* shows a flood enclosure that is used to protect utilities from shallow flooding.

**Figure 4.1B:**  
Flood enclosure to protect utilities from shallow flooding





This chapter does not apply to substantially damaged or substantially improved buildings. See Section 2.4 for further information.

Retrofitting measures can either be passive or active in terms of necessary human intervention. Active and emergency retrofitting measures are effective only if there is sufficient warning time to mobilize the labor and equipment necessary to implement the measures. Therefore, every effort should be made to design retrofitting measures that are passive and do not require human intervention.

It is important to note that where elevation above the DFE is not possible or practical, it may be feasible to combine elevation with component protection. A component can be elevated to a higher level and then shielded for added protection. Even a small increase in elevation can reduce future flood damage.

### 4.2 Field Investigation

Prior to the start of a retrofitting project, a field investigation should be conducted to gather detailed information that can be used to make decisions concerning the feasibility of the project and which method of flood damage protection should be used. *Figure 4.2* is a worksheet that provides the basic format for a field investigation. In addition to the information in the worksheet, the following issues should also be examined:

- Previous floods, which equipment was flooded in prior floods, and which appliances and circuits were affected by previous floods.
- Plan of action as to which equipment can be relocated and which equipment will have to remain located below the DFE.
- Length of power outage, water shut-off, or fuel shut-off while work is being done.
- Unsafe practices and code violations by current design.

#### NOTE:

The Design Flood Elevation (DFE) is a regulatory flood elevation adopted by a community that is the BFE, at a minimum, and may include freeboard, as adopted by the community.



Owner Name: \_\_\_\_\_ Prepared By: \_\_\_\_\_  
Address: \_\_\_\_\_ Date: \_\_\_\_\_  
Property Location: \_\_\_\_\_

### Flood Resistant Retrofitting Field Investigation Worksheet

Design Flood Elevation (DFE) \_\_\_\_\_

#### HVAC System

- Can all equipment be protected in-place? \_\_\_Yes\_\_\_No
- Is it feasible to install a curb or “pony” wall around equipment to act as a barrier? \_\_\_Yes\_\_\_No
- Is it feasible to construct a waterproof vault around equipment below the DFE? \_\_\_Yes\_\_\_No
- Can reasonably sized sump pumps keep water away from the equipment? \_\_\_Yes\_\_\_No
- Can equipment feasibly be relocated?
- To a pedestal or balcony above the DFE? \_\_\_Yes\_\_\_No
- To a higher level on the same floor level? \_\_\_Yes\_\_\_No
- To the next floor level? \_\_\_Yes\_\_\_No
- Is space available for the equipment in the alternate location? \_\_\_Yes\_\_\_No
- Can existing spaces be modified to accept equipment? \_\_\_Yes\_\_\_No
- Is additional space needed? \_\_\_Yes\_\_\_No
- Do local codes restrict such relocations? \_\_\_Yes\_\_\_No

#### Fuel System

- Can all equipment be protected in-place? \_\_\_Yes\_\_\_No
- Is the tank properly protected against horizontal and vertical forces from velocity flow and buoyancy? \_\_\_Yes\_\_\_No
- Is it feasible to install a curb or “pony” wall around equipment to act as a barrier? \_\_\_Yes\_\_\_No
- Is it feasible to construct a waterproof vault around equipment below the DFE? \_\_\_Yes\_\_\_No
- Can reasonably sized sump pumps keep water away from the equipment? \_\_\_Yes\_\_\_No
- Is the meter properly protected against velocity and impact forces? \_\_\_Yes\_\_\_No

Figure 4.2: Retrofitting field investigation worksheet (page 1 of 3)



- Do local code officials and the gas company allow the meter to be relocated to a higher location? \_\_\_Yes\_\_\_No
- Can equipment feasibly be relocated?
- To a pedestal or balcony above the DFE? \_\_\_Yes\_\_\_No
- To a higher level on the same floor level? \_\_\_Yes\_\_\_No
- To the next floor level? \_\_\_Yes\_\_\_No
- Is space available for the equipment in the alternate location? \_\_\_Yes\_\_\_No
- Can existing spaces be modified to accept equipment? \_\_\_Yes\_\_\_No
- Is additional space needed? \_\_\_Yes\_\_\_No
- Do local codes restrict such relocations? \_\_\_Yes\_\_\_No

### Electrical System

- Is it feasible to relocate the meter base and service lateral above the DFE? \_\_\_Yes\_\_\_No
- Is it feasible to relocate the main panel and branch circuits above the DFE? \_\_\_Yes\_\_\_No
- Is it feasible to relocate appliances, receptacles, and circuits above the DFE? \_\_\_Yes\_\_\_No
- Is it feasible to relocate light switches and receptacles above the DFE? \_\_\_Yes\_\_\_No
- Can ground fault interrupter protection be added to circuits below the DFE? \_\_\_Yes\_\_\_No
- Can service lateral outside penetrations be sealed to prevent water entrance? \_\_\_Yes\_\_\_No
- Can cables and/or conduit be mechanically fastened to prevent damage during flooding? \_\_\_Yes\_\_\_No
- Can splices and connections be made water resistant or relocated above the DFE? \_\_\_Yes\_\_\_No
- Do local code officials and electric companies allow the elevation of the meter? \_\_\_Yes\_\_\_No

### Sewage Management Systems

- Can the on-site system be protected in-place? \_\_\_Yes\_\_\_No
- Is it feasible to anchor the tank? \_\_\_Yes\_\_\_No
- Can the distribution box and leech field be protected from scour and impact forces? \_\_\_Yes\_\_\_No

Figure 4.2: Retrofitting field investigation worksheet (page 2 of 3)

## Existing Buildings



- Can the supply lines be properly protected from scour and impact forces? \_\_\_Yes\_\_\_No
- Can backflow prevention valves be used to minimize flow of sewage into the building? \_\_\_Yes\_\_\_No
- Can equipment feasibly be relocated?
- Can the system be moved to a higher elevation on the property? \_\_\_Yes\_\_\_No
- Can the tank be relocated to a higher elevation or indoors? \_\_\_Yes\_\_\_No
- Can the drains and toilets be relocated above the DFE? \_\_\_Yes\_\_\_No
- Is space available for the equipment in the alternate location? \_\_\_Yes\_\_\_No
- Can existing spaces be modified to accept equipment? \_\_\_Yes\_\_\_No
- Is additional space needed? \_\_\_Yes\_\_\_No
- Do local codes restrict such relocations? \_\_\_Yes\_\_\_No

### Potable Water Systems

- Can the well be protected in-place? \_\_\_Yes\_\_\_No
- Is it feasible to install a curb or “pony” wall around equipment to act as a barrier? \_\_\_Yes\_\_\_No
- Is it feasible to construct a waterproof vault around equipment below the DFE? \_\_\_Yes\_\_\_No
- Can the wellhead and tank be protected from scour and impact forces? \_\_\_Yes\_\_\_No
- Can the supply lines be properly protected from scour and impact forces? \_\_\_Yes\_\_\_No
- Can backflow prevention valves be used to minimize flow of floodwaters into the water source? \_\_\_Yes\_\_\_No
- Can equipment feasibly be relocated?
- Can the well be moved to a higher elevation on the property? \_\_\_Yes\_\_\_No
- Can the electric controls for the well be protected from inundation? \_\_\_Yes\_\_\_No
- Can the tank be relocated to a higher elevation or indoors? \_\_\_Yes\_\_\_No
- Can the taps be relocated above the DFE? \_\_\_Yes\_\_\_No
- Is space available for the equipment in the alternate location? \_\_\_Yes\_\_\_No
- Can existing spaces be modified to accept equipment? \_\_\_Yes\_\_\_No
- Is additional space needed? \_\_\_Yes\_\_\_No
- Do local codes restrict such relocations? \_\_\_Yes\_\_\_No

Figure 4.2: Retrofitting field investigation worksheet (page 3 of 3)



### 4.3 Retrofitting Scenarios

#### Overview

This section outlines basic retrofitting scenarios. In addition to the basic concerns outlined later in this section, additional concerns may exist for particular building types. *Table 4.3* shows the five basic types of buildings and identifies issues that may be of particular concern for the building types.

**NOTE:**

In every retrofitting project, it is imperative to ensure that the impact of the retrofitting measures upon the existing building and its attendant utilities is thoroughly investigated and assessed to ensure that the project meets the local building code and floodplain management requirements. It may be necessary to make structural and other modifications in order to accommodate the retrofitting measures.

**CAUTION:**

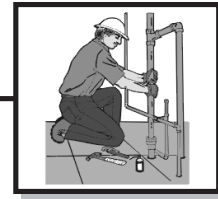
This chapter does not apply to substantially damaged or substantially improved buildings. See Section 2.4 for further information.

	House on basement/ split level/bi-level	Slab-on-grade	Crawlspace	Elevated foundation	Garage
Ensure that exterior HVAC system components are sufficiently protected from debris impact, velocity flow, wave action, erosion, scour, and wind and water inundation	✓	✓	✓	✓	
Ensure that ductwork located below the DFE is relocated or protected to prevent water infiltration	✓		✓	✓	
Ensure that water heaters and boilers are protected or relocated to prevent inundation by floodwaters	✓	✓	✓	✓	
Ensure that exterior fuel tanks are properly protected against erosion, scour, buoyancy, debris impact, velocity flow, and wave action.	✓	✓	✓	✓	✓
Ensure that interior fuel tank is properly protected against buoyancy and impact forces	✓				✓
Electrical equipment located below the DFE should be protected from inundation	✓			✓	✓
Ensure that wiring is relocated above the DFE, or that wires below the DFE are installed to minimize the risk of water infiltration and damage	✓		✓	✓	✓
Ensure that electrical components located below the DFE are not attached to breakaway walls of buildings in V Zones				✓	
Ensure that water and sewer lines are protected from backflow	✓	✓			
Ensure all water, sewer and fuel pipes are adequately protected to prevent damage caused by erosion, scour, debris impact, velocity flow, and wave action	✓	✓	✓	✓	

Table 4.3: Special concerns for five building types



## Existing Buildings



The scenarios that begin on the next page generally have options listed in order of the most to the least preferred flood protection approaches for HVAC Systems, Fuel Systems, Electrical Systems, Sewage Management Systems, and Potable Water Systems. Typically, the most preferred option is presented and then several other options are explored. Note that this section only applies to retrofitting of existing buildings that are not substantially damaged or substantially improved. Refer to Sections 3.1 through 3.5 for a detailed explanation of flood resistant building utility systems for new, substantially damaged, or substantially improved buildings. In addition, Sections 3.1 through 3.5 contain many figures that might be helpful for visualization of the various retrofit scenarios located in this chapter.

### Evaluation of Risk

For buildings constructed in the floodplain, there is a risk of serious flood damage to most, if not all, building utility systems constructed below the DFE. The level of risk depends on several factors, including the number of utility systems located below the DFE and their location relative to the building footprint.

### Analysis of Various Utility Systems

#### 1. Heating, Ventilating, and Air Conditioning (HVAC) Systems

- a. Compressor, heat pump, and other outdoor equipment:
  - Is expected flooding shallow enough that the equipment can be put up on a pedestal?
  - If not, can the equipment be moved to a porch or other location above the DFE?
  - If not, construct a balcony to elevate the equipment.
  - If the building is located in a shallow flood area, can a dry floodproof enclosure be built around the equipment?
- b. Furnace, boiler, water heater, and other indoor equipment:
  - Can the equipment be moved to a location above the DFE that is accessible to the duct work?
  - If not, can the equipment be elevated above the DFE on a pedestal at its present location?



This chapter does not apply to substantially damaged or substantially improved buildings. See Section 2.4 for further information.



Refer to Section 3.1.3 of this manual for an illustration of a flood shield.



- If not, can a lateral furnace be suspended from the basement ceiling above the DFE or placed in the attic? (Note: there is an additional cost associated with replacing a traditional furnace with a lateral furnace; however, a lateral furnace can be protected from future flood damage.)
  - If not, place the equipment on a pedestal inside the house as high as possible, even if the equipment elevation remains below the DFE.
  - If the building is located in a shallow flood area, can a dry floodproof enclosure be built around the equipment?
- c. Fuel pipes and electrical wiring: see the discussion of Fuel Systems and Electrical Systems that follow for appropriate protection measures.
- d. Air ducts:
- Can the duct work be elevated above the DFE?
  - If not, can the ducts below the DFE be replaced with watertight ducts? This option may be very expensive, but can be cost-effective in some applications.
  - If not, make sure the ducts below the DFE are accessible and can be disassembled for thorough cleaning. (Note: if the ducts are not protected from flooding, then they must be thoroughly cleaned after a flood. Sediment and contaminants in the ducts can be circulated through the HVAC system if it is operated with dirty ducts.)
  - Can return and supply registers be located above the DFE?
  - If not, the ducts leading to the registers should be designed to allow ample access for cleaning, thorough drainage, and be installed without insulation to prevent mold growth in the ducts.



## 2. Fuel Systems

- a. Fuel storage tank (if applicable):
- Is the above-ground tank properly protected from buoyancy and impact forces?
  - If not, can the equipment be elevated above the DFE on a pedestal?
  - If not, can the equipment be elevated above the DFE on structural fill?

### NOTE:

Refer to Section 3.2.3.1 of this manual for a discussion of buoyancy forces.

## Existing Buildings



- If not, can the tank be buried and anchored?
- If not, can the tank be relocated inside a building?
- If not, replace the tank with an above ground vault.

### b. Outdoor pipes:

- Are all pipes above the DFE?
- If not, strap them to the downstream or landward side of a building support and encase them with pipe or a chase to protect them from scour and impact forces.
- Are all pipe penetrations above the DFE?
- If not, make them watertight and use thick walled metallic piping to resist ground movement.

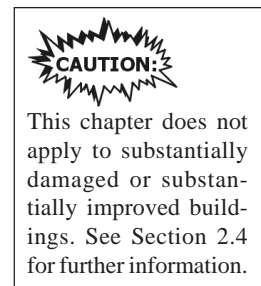
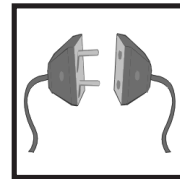
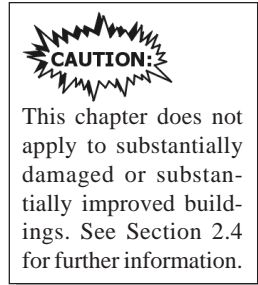
## 3. Electrical Systems

### a. System equipment (meter, main service panel, breaker and fuse boxes, and transformer):

- Is all system equipment located above the DFE?
- If not, can all of the equipment be relocated above the DFE?
- If not, move the equipment as high as possible, even if the equipment elevation remains below the DFE.

### b. Distribution system (wiring, receptacles, outlets and switches):

- Are all system components located above the DFE?
- If not, can all receptacles, outlets and switches below the DFE be elevated or removed?
- If not, place the receptacles remaining below the DFE on one or two separate circuits. Install and clearly identify ground fault circuit interrupter breakers on those circuits. (Note: receptacles and switches below the DFE should be installed in non-corrosive boxes with holes punched in the bottom to facilitate drying. The receptacles will have to be replaced after inundation by floodwaters.)





### NOTE:

Refer to Section 3.4.4 of this manual for an illustration of a combination check and gate valve.

### CAUTION:

This chapter does not apply to substantially damaged or substantially improved buildings. See Section 2.4 for further information.



## 4. Sewage Management Systems

- a. Install an appropriate sewer backup control measure:
  - Are all collection system components located above the DFE?
  - If not, can all collection system components within the building be elevated above the DFE?
  - If not, install a non-return backflow valve or a combination of check and gate valves in the public sewer service connection pipe to protect against sewage backup.
- b. Protect all external pipes and building penetrations. Refer to Fuel Systems discussion in Section 3.2 for details.
- c. A plug should be installed in all sewer openings below the DFE (e.g., toilet or sink drain) to prevent sewage from backflowing into the building.
- d. Septic tank (if applicable):
  - Is the septic system located above the DFE?
  - If not, seal the septic tank to prevent contamination of the floodwaters by the contents of the tank.
  - If not, anchor or otherwise prevent the tank from becoming buoyant. Refer to Section 3.2.3.1 for a comprehensive look at buoyancy forces.
  - If not, protect the tank from erosion and scour.

## 5. Potable Water Systems

- a. Plumbing fixtures (outdoor faucets, shower heads, and utility sinks):
  - Are all plumbing fixtures located above the DFE?
  - If not, can they all be elevated above the DFE?
  - If not, install back-flow valves on pipelines leading to fixtures or on the fixtures located below the DFE to prevent floodwaters from contaminating the water supply.
- b. Protect all external pipes and building penetrations from impact and scour forces and leakage.
- c. Seal the well top using a watertight casing to prevent inflow and contamination. Also, protect the well top from scour and impact forces that could damage it and breach the water supply system.