Floodproofing Non-Residential Buildings

- Design Manual (FEMA P-936)
  1. Existing non-residential buildings in riverine areas subject to shallow flooding and in coastal areas not subject to wave action
  2. Certain core areas of critical facilities
  3. Buildings subject to frequent, low-level flooding for a level of protection lower than the base flood elevation (BFE)
# Organization of the Guide

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Definitions

- **Floodproofing**: Any combination of structural or nonstructural adjustments, changes, or actions that reduce or eliminate flood damage to a building, contents and attendant utilities and equipment.

- **Dry Floodproofing**: A combination of measures that results in a structure, including the attendant utilities and equipment, being watertight with all elements substantially impermeable and with structural components having the capacity to resist flood loads.

- **Wet Floodproofing**: The use of flood-damage-resistant materials and construction techniques to minimize flood damage to areas below the flood protection level of a structure, which is intentionally allowed to flood.
Definitions (cont’d)

- **Floodwall**: Constructed barrier of flood-damage-resistant materials to keep water away from or out of a specified area. Floodwalls surround a building or area and are off-set from the exterior walls of the building.

- **Levee**: Manmade barrier, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to hold water back.
Key Concepts

- Passive vs. Active measures

  - **Passive measures** do not require human intervention and are recommended whenever possible.
  
  - **Active measures** (also referred to as emergency measures) require human intervention and are effective only if there is enough warning time to mobilize the labor and equipment necessary to implement them and safely evacuate.

- **Sub substantially impermeable**: A wall is considered substantially impermeable if it limits water accumulation to 4 inches in a 24 hour period. In addition, sump pumps are required to control any seepage.

- **Insurance Implications**: Active vs. Passive; Different rates for floodproofing depths.
Limitations of Floodproofing

- Residual risk
  - Flood damage potential
  - Performance of building above floodproofing design level

- Space below the floodproofing design level may be usable space, but is still at risk. Building owners should consider what is stored and the function of these areas.

- Floodproofed buildings should not be occupied during a flood
## Dry Floodproofing Considerations

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Issues for Consideration</th>
</tr>
</thead>
</table>
| **Building strength**      | • Is the building strong enough to resist flood-related forces?  
  • Can retrofits be made to strengthen the structure? |
| **Warning time**           | Is warning time required to activate or deploy a floodproofing measure? |
| **Flood characteristics**  | Is the building located in an area where flooding is expected to persist for longer than 12 hours? |
| **Level of protection**    | Are floodwaters at the site expected to be greater than three feet? |
Dry Floodproofing Considerations (cont’d)

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Issues for Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Building location</strong></td>
<td>Is the building located in a Coastal A Zone or Zone V?</td>
</tr>
<tr>
<td><strong>Operational considerations</strong></td>
<td>Can the building maintenance be augmented to include considerations for the dry floodproofing measure?</td>
</tr>
<tr>
<td><strong>Seepage considerations</strong></td>
<td>Measures to remove water that infiltrates the building are necessary.</td>
</tr>
<tr>
<td><strong>Utilities</strong></td>
<td>• Can alternate power be provided for sump pumps?</td>
</tr>
<tr>
<td></td>
<td>• Can underground utilities be sealed to prevent backflow of floodwaters into the building?</td>
</tr>
<tr>
<td></td>
<td>• Can electrical utilities below the flood protection level be protected from floodwaters?</td>
</tr>
<tr>
<td><strong>Substantial Improvement/Damage</strong></td>
<td>Is the building undergoing Substantial Improvement or has it incurred Substantial Damage?</td>
</tr>
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Dry Floodproofing Measures
## Dry Floodproofing Measures

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tr>
<td>May be less costly than other retrofitting methods</td>
<td>Active dry floodproofing measures require human intervention and adequate warning</td>
</tr>
<tr>
<td>Do not require the land that may be needed for levees and floodwalls</td>
<td>Do not always minimize the potential damage from high-velocity flood flow or wave action</td>
</tr>
<tr>
<td>May qualify for FEMA assistance</td>
<td>Require ongoing maintenance</td>
</tr>
<tr>
<td>May be used to bring a substantially damaged or substantially improved non-residential structure into compliance with the community’s floodplain management regulations and codes</td>
<td>Flood shields may not be aesthetically pleasing</td>
</tr>
<tr>
<td>Can be used to protect against more frequent flooding even if it is not cost-effective to floodproof to the BFE/DFE</td>
<td>Potential failure of the structure’s walls and/or property damage if the flood event is greater than the level of protection to which the dry floodproofing measure was designed</td>
</tr>
</tbody>
</table>
Dry Floodproofing Measures

Preparation

- Site and building evaluation
  - Regulatory Requirements
  - Loads
  - Structural capacity
  - Points of entry
Dry Floodproofing Measures

- Minimum floodproofing elevation
  - Flood Insurance Manual – 1’ above BFE
  - ASCE 24

<table>
<thead>
<tr>
<th>ASCE Structure Category</th>
<th>Minimum Floodproofing Elevation (Zone A)</th>
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<tbody>
<tr>
<td>I, II, and III</td>
<td>BFE + 1 foot or DFE, whichever is higher</td>
</tr>
<tr>
<td>IV</td>
<td>BFE + 2 foot or DFE, whichever is higher</td>
</tr>
</tbody>
</table>

- Sufficient warning time to deploy active dry floodproofing measures and vacate the building
  - ASCE 24 requires a minimum of 12 hours unless other conditions are met
Dry Floodproofing Measures

Continuous impermeable walls

- Substantially impermeable
  - no more than 4” water depth will accumulate during a 24-hour period
- Capable of resisting hydrostatic and hydrodynamic loads as well as the effects of buoyancy
Dry Floodproofing Measures

Continuous impermeable walls

Consider:

- Type of construction (Masonry, Poured Concrete, SIP, ICF)
- Connections between walls and walls and floors
- Penetrations for utilities and other openings in the walls and floor
- Type of sealant system (positive-side or negative-side)
- Remember that they will still leak, so develop an interior drainage system
- Consider walls of adjacent buildings
Dry Floodproofing Measures

Continuous impermeable walls

- SERRI Example
  - CMU wall system
    - Cross section of the test mock-up
  - Not intended for design purposes
Dry Floodproofing Measures

- Measures must protect *ALL* openings not just windows and doors
- Consider vents and other openings
Dry Floodproofing Measures

Flood resistance in interior core areas

- “Floodproofed enclosure” for areas such as mechanical or electrical equipment, which can’t be relocated.
Dry Floodproofing Measures

Interior Core Areas

- May be located well below ground
- Designs may require high hydrostatic loads
- Designs should incorporate buoyancy forces and anchorage requirements
- Will need its own pump system, power supply, and possibly ventilation system
Tulane Medical Center, New Orleans

- Core Area
  - Shields
  - Door
  - Reinforced walls
Dry Floodproofing Measures

Opening protection

- Transfer of the flood loads from the door, panel, or shield to the wall
- Reinforcing/Retrofitting walls may be necessary
Dry Floodproofing Measures

Flood Shields and Openings for Exterior Walls

- Considerations for Flood Shields
- Type of Opening (pedestrian doors, windows, rollup doors, etc.)
- Passive or Active Style Shields
- Shield Materials (strength, weight, durability)
- Type and Maintenance of Gaskets and Seals
- Storage of shields when not in use
Dry Floodproofing Measures

Dry floodproofing of utility systems

- Elevate, enclose, create redundancies, etc.
- Emergency connection
- Protect Conduits
Dry Floodproofing Measures

Backflow prevention

- Essential in areas with combined sewer system
- Maintenance is necessary
- Applicable where allowed by local jurisdictions.
Dry Floodproofing Measures

Internal drainage systems (Sump Pumps)

- Remove seepage
- Remove water collected from underdrain systems
Dry Floodproofing Measures

Sump Pump Design Considerations

- Pump capacity (gallons per minute or gallons per hour)
- Pump head (vertical height the water is lifted)
- Frictional resistance of fluid flow in the discharge piping system
- Electrical power required for the pump
  - Small buildings are usually powered by 120/240 volt, single-phase AC
  - Larger buildings may have three-phase systems with higher voltages
- Type of pump activation switch system
- Pumping System Type: Constant Speed or Variable Speed
Dry Floodproofing Measures

Other Internal Drainage Systems

- Underdrain Systems – can feed sump pumps
- Pressure Relief Systems – allow floodwaters to enter rather than risk damages
Dry Floodproofing Measures

Floodproofing Certificate

- Must be designed by a qualified registered design professional
- Design Elevation
  - must be 1’ above BFE for Insurance rating purposes
- Resist flood and anticipated debris impact forces
- Watertight with walls that are substantially impermeable

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Dry Floodproofing Measures

Operations and maintenance plan

- A plan for deploying any active dry floodproofing measures that require human intervention
- Storage location
- Routine rehearsals
- Testing, inspecting, and repairs
- Recommend annual review of plans when renewing flood insurance policy
Dry Floodproofing Measures

Maintenance

- Verify no additional penetrations below DFE
- Inventory and install necessary hardware
- Test emergency power sources and equipment (e.g., sump pump)
- Evaluate gaskets
True or False

A dry floodproofing measure’s Design Flood Elevation (DFE) must be at or above BFE for insurance rating purposes.
True or False

Flood resistant interior core areas/floodproof enclosure protect critical building systems and provide occupants an emergency shelter during a flood.
Multiple Choice

A substantially impermeable wall should limit water accumulation to a maximum accumulation of:

A. 3 inches in a 24-hour period with a sump
B. 4 inches in a 12-hour period with a sump
C. 4 inches in a 24-hour period with a sump
D. 2 inches in a 24-hour period with a sump
True False

Design professionals need to be aware of several requirements not explicitly noted on current flood proofing certificates.