Understanding Foundation Flood Vents and FEMA Technical Bulletin 1
Learning Objectives

At the completion of this course, you will be able to:

- Identify the effects of hydrostatic pressure on building sustainability
- Explain the role of foundation flood vents on building enclosure performance in relationship to air, water and land use
- Identify FEMA regulations and ICC building codes as they relate to sustaining foundations in flood hazard areas
- Analyze the differences between engineered and non-engineered foundation flood openings in terms of optimizing health, durability, maintenance
**Course Outline**

**Section 1**
- NFIP (FEMA) regulations and ICC building codes
- The role of foundation flood vents in sound floodplain construction
- Enclosure
- Placement

**Section 2**
- Options for meeting foundation flood vent opening requirements
  - Non-engineered openings: definitions and compliance criteria
  - Engineered openings: definitions, principles of operation, certifications and benefits
  - LEED® points

**Section 3**
- Specifying engineered foundation vent openings: features and available products

**Case Studies**
- New residence, post-Katrina, LA
- New church, post-Katrina, LA

*Specifying Foundation Flood Vents for Building Sustainability, Durability and Performance*
Section 1

- NFIP (FEMA) regulations and ICC building codes
- Basic terms
- The role of foundation flood vents in sustainable, sound floodplain construction
- Enclosure: definition and examples
- Proper vent placement
NFIP (National Flood Insurance Program)

- An important objective of the National Flood Insurance Program (NFIP) is to protect buildings constructed in floodplains from structural damage caused by flood forces.

- NFIP regulations include building design criteria that apply to new construction and substantial improvements of existing buildings in Special Flood Hazard Areas (SFHAs).

- Managed by FEMA, the Federal Emergency Management Agency of the US Government.

- Nearly 20,000 US communities participate in the NFIP by enforcing floodplain management ordinances. In exchange the NFIP offers federally backed flood insurance.
The NFIP regulations state that a community shall:

- “Require, for all new construction and substantial improvements, that fully enclosed areas below the lowest floor that are usable solely for parking of vehicles, building access, or storage in an area other than a basement and which are subject to flooding shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwaters.”

Title 44 of the Code of Federal Regulations, in Section 60.3(c)(5)
NFIP regulations

Buildings constructed in compliance with NFIP standards:

- Respond to the ecological context at the local scale
- Suffer approximately 80% less damage annually than those not in compliance.
- Achieve greater durability
- Require less maintenance
**NFIP (FEMA):**

- **BFE (Base Flood Elevation)** This is the elevation above the average sea level that waters will reach in a 1% (100-year) flood.

- **A Zones** Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage.

- **V Zones** are Coastal areas with a 1% or greater chance of flooding with an additional hazard associated with storm-induced waves.

- **Freeboard** is elevating a building’s lowest floor above and beyond BFE
  - A built-in safety factor resulting in lower flood insurance premiums
How hydrostatic pressure works

- Buoyancy Force
- Flood Level
- Ground
- Additional Pressure from Saturated Soil
- Hydrostatic Pressure
- Buoyancy Force
Effects of outside lateral hydrostatic force
Effects of inside lateral hydrostatic force
Effects of vertical hydrostatic force
Effects of vertical hydrostatic force
What is a foundation flood vent?

- A device used to sustain a structure during a flood.
- It relieves (rather than resists) excessive hydrostatic pressure on foundation walls during a flood event. The flood vent must allow for the automatic entry and exit of flood waters without human intervention.
- Use of foundation flood vents is known as “wet flood proofing.”
- According to FEMA regulations and ICC building codes, in all residential A zone construction “wet flood proofing” techniques are required.
Why install foundation flood vents?

- To help protect and sustain homes from the devastation and destruction that a hurricane, flood or other natural disaster can cause.

- ICC (International Code Council) building codes demand flood ventilation in all non-commercial structures located within a floodplain.

- Are required by FEMA and the National Flood Insurance Program (NFIP)

- All homes located within a flood zone that have a mortgage, must have flood insurance.

- Insurance premiums may decrease — often substantially — when a homeowner installs proper flood vents.
Why install foundation flood vents?

- Since the nation’s floodplain is constantly growing, compliant floodplain construction is increasingly critical.

- Foundation flood vents can contribute to LEED® certification points.

- Foundation flood vents offer a way to preserve and reuse structures in a designated flood zone.

- Enhance performance of building enclosures in flooding situations in relation to air, water and land use.

- Optimize sustainability, durability, and maintenance of structures.
“Enclosure” is that portion of an elevated building below the lowest elevated floor that is either partially or fully shut in by rigid walls (NFIP).
Types of enclosures: Crawlspace
Types of enclosures: Full height enclosures (townhouse)
Types of enclosures: Attached garages
Types of enclosures: Full height enclosures (Multi-family homes)
Types of enclosures: Full height enclosures Single-Family Dwelling (SFD)
Types of enclosures: Detached accessory

- Regulated as enclosures
Enclosures in V Zones
What makes an enclosure compliant?

- In A Zones, fully enclosed areas below the BFE must be designed to automatically equalize hydrostatic flood forces on exterior walls.
  - Flood vents

- In V Zones, the space below the lowest floor of a building shall be free of obstruction or constructed with non-supporting breakaway walls.
  - Vents are recommended but not required by FEMA.
  - In shallow flood situations vents may save the breakaway walls from being replaced.

(Source: FEMA Technical Bulletin 1: Openings in Foundation Walls and Walls of Enclosures)
What makes an enclosure compliant?

Not a basement

- A floor that is below ground level (grade) on all sides is considered a basement.

(Source: FEMA Technical Bulletin 1: Openings in Foundation Walls and Walls of Enclosures)

TB-11: Crawlspace Construction for Buildings Located in Special Flood Hazard Areas.
What makes an enclosure compliant?

Unfinished/flood-resistant materials

- Materials used below the BFE must be made of flood-resistant materials such as stainless steel and pressure treated lumber.

Utilities and mechanicals need to be elevated and protected

- All the utilities around and in the enclosure must be elevated above the BFE

(Source: FEMA Technical Bulletin 1: Openings in Foundation Walls and Walls of Enclosures)
Enclosures below BFE may only be used for

- Parking of vehicles
- Storage (“low value” storage)
- Building access (foyers, stairs)

(Source: FEMA Technical Bulletin 1: Openings in Foundation Walls and Walls of Enclosures)
Placement of Flood Vents:

NFIP regulations require:

- “The bottom of all openings shall be no higher than one foot above grade.”
Placement

- Vents on at least two different walls.
Placement
Sloping Sites: Walk Out Basements

Each opening no more than 1' above grade

Interior grade must be at or above the exterior grade along the entire length of the lowest side to prevent being a basement

(Drawing source: FEMA TB-1)
Section 2

Options for meeting foundation flood vent opening requirements

- Non-engineered openings: definitions and compliance criteria
- Engineered openings: definitions, principles of operation, certifications and benefits
- LEED® points
NFIP permits two options: Engineered and Non-engineered Openings

- Definitions for both options found in FEMA’s Technical Bulletin 1 and the ICC’s IRC and IBC
- Both FEMA and the ICC reference ASCE 24-05
- ASCE requires that flood openings allow for a 3 in. sphere to pass through the vent to allow debris to enter and exit the foundation
A non-engineered opening is an opening that is used to meet the NFIP’s prescriptive requirement of 1 square inch of net open area for every square foot of enclosed area.

- IMPORTANT to measure net open area
- An 16 in. x 8 in. hole with an air vent inserted does NOT provide 128 sq. in.
Non-engineered flood vent openings

Measure “net open area”

Typical air vents provide on the order of 42 sq in net open area or less. Use rating for ventilation if provided.
Non-engineered flood vent openings

Net opening area: Let’s do the Math

- Footprint ± 30’x40’ = 1200 sf
- 1200/42 sq. in. = (29) total vents

Bill Bryant/Anne Arundel Co, MD
Non-engineered flood vent openings

- An insect or rodent screen must be installed over an opening according to the ICC codes.
- Obstructions to flow should be considered when measuring net area.
- Non-engineered openings must remain open at all times.
Non-engineered flood vent openings

Debris blockage decreases vent’s efficiency
Non-engineered flood vent openings

Unacceptable Measures

- Standard foundation air ventilation devices that can be closed manually, unless they are disabled in the open position.

(Source: FEMA Technical Bulletin-1 page 19)
Non-engineered flood vent openings

Unacceptable Measures

- Standard foundation air ventilation devices that have detachable solid covers that are intended to be manually installed over the opening in cold weather, because they do not allow for the automatic entry and exit of floodwaters when the cover is in place.

(Source: FEMA Technical Bulletin-1 page 19)
Unacceptable Measures

- Standard foundation air ventilation devices that are designed to open and close based on temperature.

(Source: FEMA Technical Bulletin-1 page 19)
Non-engineered flood vent openings

Unacceptable Measures

- Windows below the BFE

(Source: FEMA Technical Bulletin-1 page 19)
Non-engineered flood vent openings

Unacceptable Measures

- Garage Doors and Standard Exterior Doors without openings installed in them.

(Source: FEMA Technical Bulletin-1 page 19)
Engineered flood vent openings

NFIP/FEMA regulations & ICC codes allow for openings that are designed and certified for performance (“engineered”)

- Engineered openings are the alternative to the prescriptive method 1 sq. in. for 1 sq. ft.

- Designed, tested, and certified based on computations (FEMA TB1 and ASCE 24)

- I-Codes & ASCE 24: 3 in. min. dimension
Engineered flood vent openings

Principles of operation:

- Vent door is latched closed until flood water enters
- Entering flood water lifts internal floats which unlatch and rotate the door open
- Flood water automatically enters and exits through the frame opening, relieving the pressure from foundation walls
- Louvers are for ventilation only, not relied on to let water in and out
- When the vent door opens, the louvers and pest screens rotate out of the path of the flood water
Engineered flood vent openings

Principles of operation ctd.:

- Ventilation louvers: A bimetal coil (like a thermostat) automatically opens and closes the louvers as the temperature changes.

- No electricity is required to operate the vents
Engineered flood vent openings

INSERT VIDEO DEMOISTRATION OF ENGINEERED VENT (TO BE TAPEDED)

TEXT TO BE ON THE VIDEO SOUND TRACK, OR SPOKEN OVER THE VIDEO

TEXT TO BEGIN: THIS IS A DEMONSTRATION OF AN ENGINEERED FOUNDATION FLOOD VENT.....
Engineered flood vent openings

Certification Methods:

- ICC-ES Evaluation Report
- Individual “live seal” certification

The Two Certification Methods Can Be Found on pages 24-26 of FEMA’s Technical Bulletin 1
Two Options

1. Simply Submit with plans.
2. For Each Home • Raised or Electronic Seal • Original Only

Specifying Foundation Flood Vents for Building Sustainability, Durability and Performance
Resources for reviewing products

Information resources:

• Product listings
• Test lab reports
• Manufacturers’ information
• Jurisdiction Evaluation Reports
• ICC-ES Evaluation reports
Building Officials’ Preference

2006 Nationwide Survey of Building Officials

80% of Building Officials prefer ICC-ES evaluation reports over other evaluation resources for approving building products.


Specifying Foundation Flood Vents for Building Sustainability, Durability and Performance
ICC-ES Report

Specifying Foundation Flood Vents for Building Sustainability, Durability and Performance

- ICC-ES Report lists the name of Manufacturer
- Different models offered
- And sq/ft that the models are certified for
Engineered flood vent openings

Advantages compared with Non-engineered foundation flood vents:

- Fewer needed which reduces the number of products required... Typical unit covers 200 sq. ft., far in excess of what a similarly sized non-engineered opening could cover.

- Manufactured in different configurations and colors to meet construction design needs

- Solutions for retrofit which conserve the amount of materials used

- Guarantees the homeowner the lowest possible flood insurance premium

- Most important: they are designed to perform in flood situations thereby preserving existing buildings

Specifying Foundation Flood Vents for Building Sustainability, Durability and Performance
Freeboard:

- Adding freeboard at time of construction is cost-effective (American Institutes for Research, 2006)
  - Reduced flood damage yields benefit cost ratio over wide range of scenarios
  - Reduces insurance premiums
### Example 2: A Zone building, slab or crawlspace foundation (no basement). $200,000 building coverage, $75,000 contents coverage.

<table>
<thead>
<tr>
<th>Floor Elevation above BFE</th>
<th>Reduction in Annual Flood Premium*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 foot</td>
<td>39%</td>
</tr>
<tr>
<td>2 feet</td>
<td>48%</td>
</tr>
<tr>
<td>3 feet</td>
<td>48%</td>
</tr>
<tr>
<td>4 feet</td>
<td>48%</td>
</tr>
</tbody>
</table>

(2006 Evaluation of the NFIP Building Standards)
Revised FEMA Elevation Certificate

Significant Changes:

- Implemented on April 1, 2009 to be phased in on a voluntary basis over 12 months.


- Instructions for Section A interior or exterior grade.

- Two new building diagrams are required: 1B raised-slab-on-grade or slab-on-stem-wall with fill. Diagram 9 sub-grade crawlspace.
Where do I find foundation flood vent codes?

- FEMA Technical Bulletin 1-08
- FEMA 44 CFR 60.3(c)(5)
- ICC 2003, 2006 & 2009 IRC R324.2.2
- ICC 2003, 2006 & 2009 IBC 1612
- ASCE 24-05 2.6

Also Referenced in Ohio Codes:
- 2006 Residential Code of Ohio Sec. R 408.6, R 323.2.1
- 2007 Ohio Building Code Section 1612.5
SS Credit 1 Site Selection

- Engineered foundation flood vents will enable redevelopment into an existing floodplain while fulfilling NFIP regulations and ICC code requirements.
SS Credit 6.1 Stormwater Design: Quality Control

- Utilizing engineered flood vents eliminates the need for fill soil to be placed under the foundation footprint
LEED® points

EA Prerequisite 2 Minimum Energy Performance

- Engineered insulated foundation flood vents provide insulation

➤ A typical insulated vent door provides R 8.34
MR Credit 1.1 Building Reuse: Maintain 75% of Existing Walls, Floors & Roofs

- MR Credit 1.2 Building Reuse: Maintain 95% of Existing Walls, Floors & Roofs

➤ Engineered foundation flood vents afford an easy retrofit into an existing foundation
EQ Prerequisite 1 Minimum IAQ Performance

- Dual function flood protection and air ventilation
- Bi-metal coil opens and closes air ventilation louvers
- Improves the buildings HVAC efficiency
- Diminishes mold buildup
ID Credit 1-1.4 Innovation in Design

- Engineered vents offer innovative solutions for existing buildings sited in floodplain
  - Stacked flood vents for large buildings
  - Mitigate structural damage in flooding — more sustainable than replacing buildings.
  - Historical structures

- Other applications
  - Automatic opening to provide a “floodgate”
  - Rooftop storm water flood control
  - Internal emergency flood relief in facilities that handle large quantities of water
Section 3

Specifying engineered foundation flood vents: features and available products
Specifying engineered foundation flood vents

- Size
- Color
- Typical features
- Pest and insect control
- Typical products available
- What to look for in a manufacturer
Specifying engineered foundation flood vents

Size:

- Manufacturers offer same size as a standard concrete masonry unit 16” wide by 8” high
- Combination models are available in a stacked and quad configuration and arrayed side by side as needed
- For large industrial and commercial projects, custom mountings are fabricated to contain various arrangements of vents in a single frame.
Specifying engineered foundation flood vents

**Color:**

- Powder coat colors applied to standard stainless steel finish are typically available: White, Wheat, Gray and Black.
Specifying engineered foundation flood vents

**Typical features:**

- Insulated
  - Typical flood-only models have a 2-in. thick foam core equivalent to 8.34 R factor
  - Weather stripping between the door and frame
- Typical air ventilated model
  - Rotating louvers that open in warm weather and close in cool weather
Specifying engineered foundation flood vents

- **Pest control**
  - Creatures small enough to fit in the vent opening cannot exert 10 to 15 pounds of pressure required to open the vent door

- **Insect & rodent control**
  - Weather stripping on insulated models
  - Louvers on dual function models are behind a rodent screen.
Typical products available:

- Dual action for air ventilation and flood venting
- Flood venting only
- Pour-in-place wall bucks
- Wood wall model
- Overhead door models
- Sleeve/trim combination and fire damper
Specifying engineered foundation flood vents

Typical products available:

- Dual action for air ventilation and flood venting is most appropriate for traditional crawlspaces where air ventilation is required in addition to flood protection
Typical products available ctd.:

- Flood vent only models are used in garages, walkout basements, accessory structures, entry foyers and conditioned crawl spaces, etc. Insulated to minimize temperature exchange between inside and outside with a 2-inch thick foam core and weather stripping between the door and frame.
Typical products available ctd.:

- Pour-in-place wall bucks
  - Typically manufactured in high strength PVC.
  - Shipped ready to install with a protective plastic film and wood bracing for installing in forms
  - Available in a variety of sizes to accommodate different wall depths
Typical products available ctd.:

- Wood wall model (insulated)
  - Used in storage areas, garages, sheds, etc. where air ventilation is not desired but flood protection is required.
  - Designed to fit between 16” on center wall studs.
Typical products available

- Overhead door model
  - Designed for easy installation into a garage or bay door
  - Typically painted white for minimal aesthetic footprint
  - Flood door is engineered to remain closed even when door is raised, but will open automatically when flooding occurs.
Specifying engineered foundation flood vents

Typical products available, ctd.:

- Sleeve/trim combination and fire damper
  - Used in situations where a fire rating is compromised
  - Or to add a finished look to an interior wall
Summary: Foundation flood vent requirements

- Minimum of two openings on different walls
- Bottom of opening no more than one foot above adjacent grade
- Not less than 1 net sq. in. for every 1 sq. ft. of enclosed area. Unless Engineered Openings are used.
- Openings must be 3” in diameter or larger
- Must automatically allow water in and out, without human intervention.
- Doors and windows do not count as vents
Case Studies

- Case studies
  - New residence, post Katrina, LA
  - New church, post Katrina, LA
Case Study 1

Project:

- Usea family home, Westwego, LA
- Requirements:
  - LEED® Platinum certification
  - Sealed crawl space
Case study — Use a family home

- Post Katrina new construction
Case study — Use a family home
Case study — Usea family home
Case study — Use a family home
Case study — Use a family home

LEED Platinum certification

- Home energy rating system
  - 45% better than conventional new home
  - Sealed insulated crawl space
Case study — Use a family home

Sealed insulated crawl space

- NFIP requirements in a floodplain
  - 14 engineered insulated flood vents were installed. An insulated flood vent was the only option to maintain the sealed crawl space design.
Case study — Usea family home

Flood insurance costs based on NFIP rates

- Adding 1 ft of freeboard above the BFE saved the Usea family 67% on their flood insurance premium.
## Case study — Use a family home

### House “A” Residential

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Square ft. enclosed area</td>
<td>2620</td>
</tr>
<tr>
<td>$ Structure coverage</td>
<td>$250,000.00</td>
</tr>
<tr>
<td>$ Contents Coverage</td>
<td>$100,000.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annual Flood Insurance Premiums</th>
<th>% reduction as first floor goes up</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Vents 1st flr 4’ below BFE</td>
<td>$12,415.00</td>
</tr>
<tr>
<td>No Vents 1st flr 3’ below BFE</td>
<td>$8,472.00</td>
</tr>
<tr>
<td>No Vents 1st flr 2’ below BFE</td>
<td>$6,708.00</td>
</tr>
<tr>
<td>No Vents 1st flr 1’ below BFE</td>
<td>$4,849.00</td>
</tr>
<tr>
<td>With Vents 1st flr @ BFE</td>
<td>$1,195.00</td>
</tr>
<tr>
<td>With Vents 1st flr 1’ ABOVE BFE</td>
<td>$400.00</td>
</tr>
</tbody>
</table>

% decrease in premium worst case to best

---

Specifying Foundation Flood Vents for Building Sustainability, Durability and Performance
Case study — Noah’s Ark Church

Case Study 2

- Project:
  - Noah’s Ark, Missionary Baptist Church, Westwego, LA
  - Post Katrina new construction

- Requirements:
  - NFIP compliant foundation
    - Flood protection
    - Air ventilated crawl space
Case study — Noah’s Ark Church
Case study — Noah’s Ark Church

Specifying Foundation Flood Vents for Building Sustainability, Durability and Performance
Case study — Noah’s Ark Church

NFIP foundation requirements

- 16 Dual action foundation flood vents
  ➤ Flood water protection
  ➤ Air ventilation
Case study — Noah’s Ark Church
Case study — Noah’s Ark Church

Flood insurance costs based on NFIP rates

- Adding 1 ft of freeboard above the BFE saved the Church 76% on their flood insurance premium.
Case study — Noah’s Ark Church

### House "B" Non Residential

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Square ft. enclosed area</td>
<td>3030</td>
</tr>
<tr>
<td>$ Structure coverage</td>
<td>$500,000.00</td>
</tr>
<tr>
<td>$ Contents Coverage</td>
<td>$500,000.00</td>
</tr>
</tbody>
</table>

### Annual Flood Insurance Premiums

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Premium</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Vents 1st flr 4’ below BFE</td>
<td>$46,486.00</td>
<td>28%</td>
</tr>
<tr>
<td>No Vents 1st flr 3’ below BFE</td>
<td>$33,394.00</td>
<td>26%</td>
</tr>
<tr>
<td>No Vents 1st flr 2’ below BFE</td>
<td>$24,845.00</td>
<td>25%</td>
</tr>
<tr>
<td>No Vents 1st flr 1’ below BFE</td>
<td>$18,582.00</td>
<td>25%</td>
</tr>
<tr>
<td>With Vents 1st flr @ BFE</td>
<td>$4,901.00</td>
<td>74%</td>
</tr>
<tr>
<td>With Vents 1st flr 1’ ABOVE BFE</td>
<td>$1,194.00</td>
<td>76%</td>
</tr>
</tbody>
</table>

% decrease in premium worst case to best
Thank You

- Thank you for your time.
- Take the short quiz to earn your AIA credit.
- Questions? Go to www.smartvent.com

This concludes the AIA Continuing Education Systems Program