

EEBA High Performance Home Summit

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



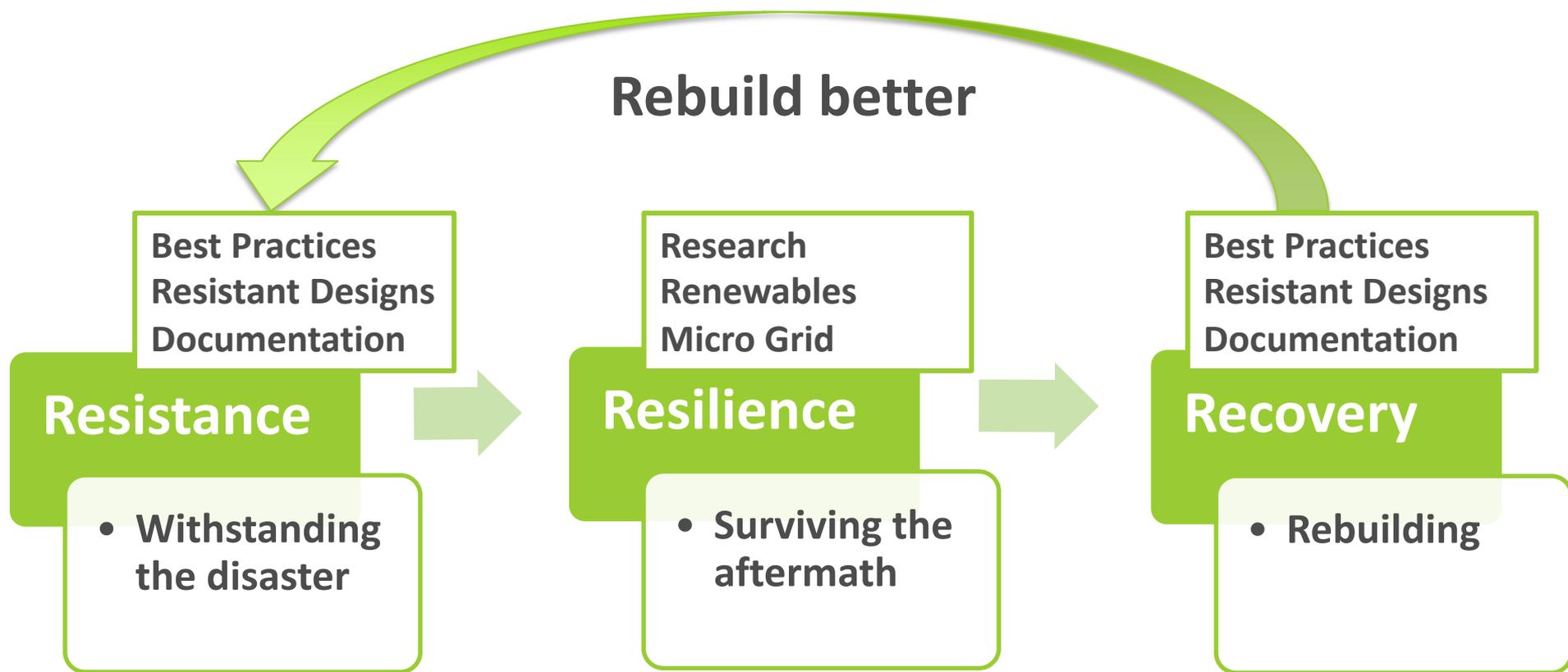
Residential High Performance & the Three “R”s: Resistance, Resilience, and Recovery

October 1, 2019

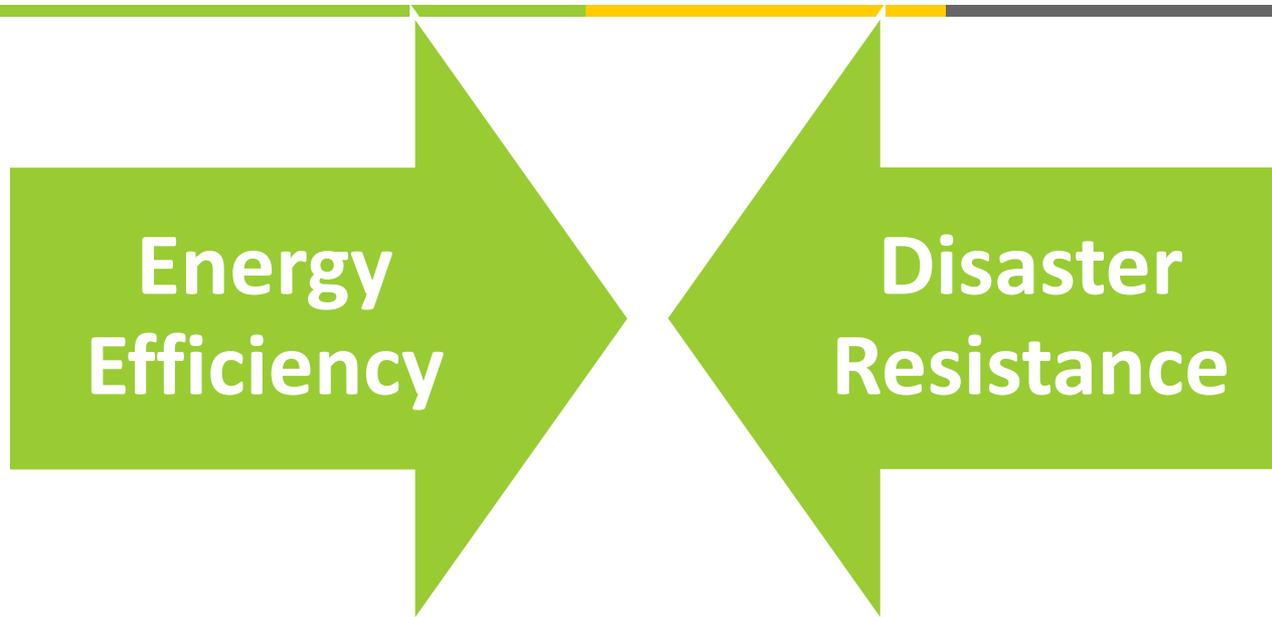
**Theresa Gilbride, Claudette Reichel,
Hunter Mantell-Hecathorn, and Michael Baechler**

Pacific Northwest National Laboratory,
Louisiana State University Ag Center, Mantell-Hecathorn Builders

Disasters are an Opportunity for High Performance



If you are doing one, you are doing the other



In storms, it's all about the Leaks

“All too often water leaks into the house through openings that are not adequately sealed during construction...

Additionally, water intrusion through soffit vents, ridge vents, gable end vents, and doors and windows can be a major source of unwanted moisture in the house....”



Best Practices from FEMA and Building America

- Weatherstrip doors and windows.
- Use water-resistant flooring in entries.
- Slope exterior grade and paved surfaces away from house.
- Install pan flashing at windows and doors.
- Properly integrate, lap, and flash thermal, air, and moisture barrier layers around doors and windows.
- Install a continuous weather-resistant barrier over roof and walls (synthetic textured house wraps, liquid-applied flashing, taped rigid foam or coated sheathing).



Flood Resistance, Resilience, Recovery





Flood Hardy Homes

- **Elevate 2-3 ft. above BFE**

(lowest flood insurance premium)

- Pier and beam
- Stemwall with flood vents
- Slab cap on filled stemwall

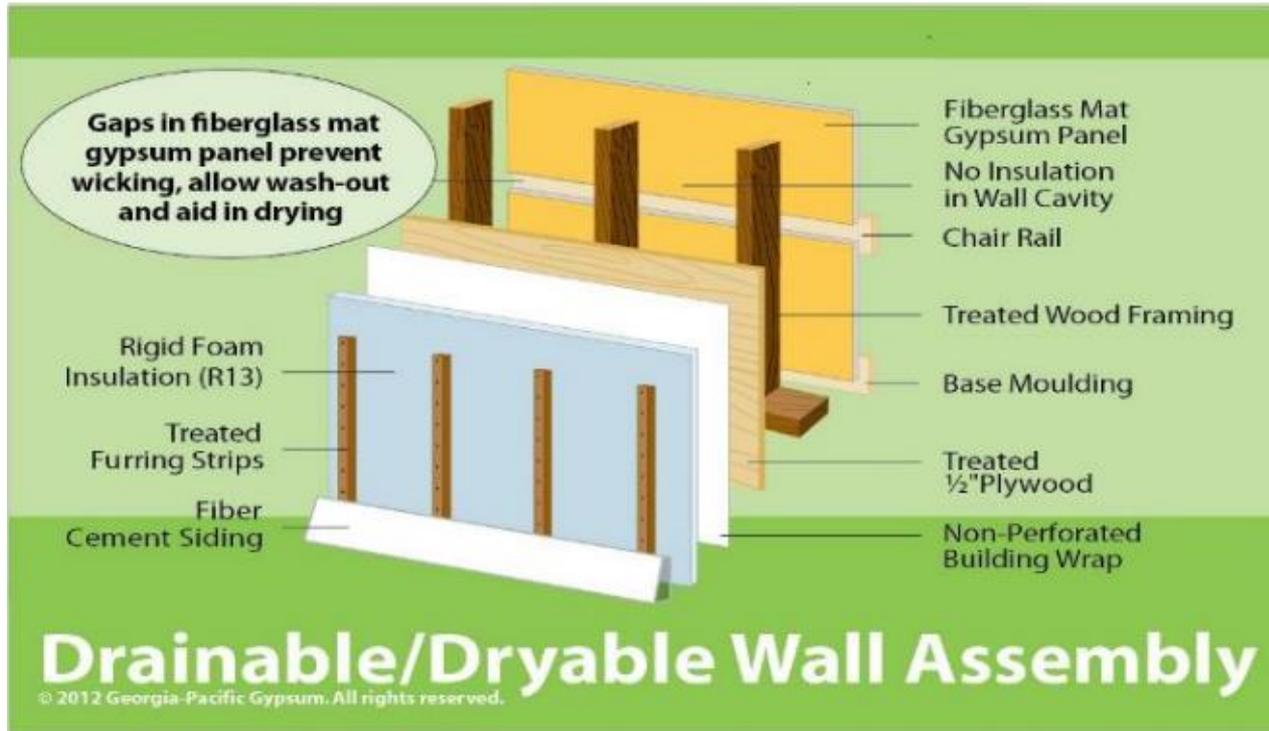
- **Wet Floodproof to possible level**

- elevate equipment, utilities
- water-resistant materials
- removable wainscoting on a drainable wall





Flood-hardy!



For homes in *levee-dependent* or *uncertain* flood level areas (potential to flood above BFE)



Flood Damage-Resistant Materials

FEMA Technical Bulletin 2

Table 2. Types, Uses, and Classifications of Materials (continued)

Types of Building Materials	Uses of Building Materials		Classes of Building Materials				
	Floors	Walls/ Ceilings	Acceptable		Unacceptable		
			5	4	3	2	1
Finish Materials (floor coverings, wall and ceiling finishes, insulation, cabinets, doors, partitions, and windows)							
Glass (sheets, colored tiles, panels)		■		■			
Glass blocks		■	■				
Insulation							
Sprayed polyurethane foam (SPUF) or closed-cell plastic foams	■	■	■				
Inorganic – fiberglass, mineral wool: batts, blankets, or blown	■	■			■		
All other types (cellulose, cotton, open-cell plastic foams, etc.)	■	■				■	



Building America Prototype Post-Katrina *Green Dream* Homes 1 & 2

(Flood-hardy, strong, durable, energy-efficient, healthy, affordable)

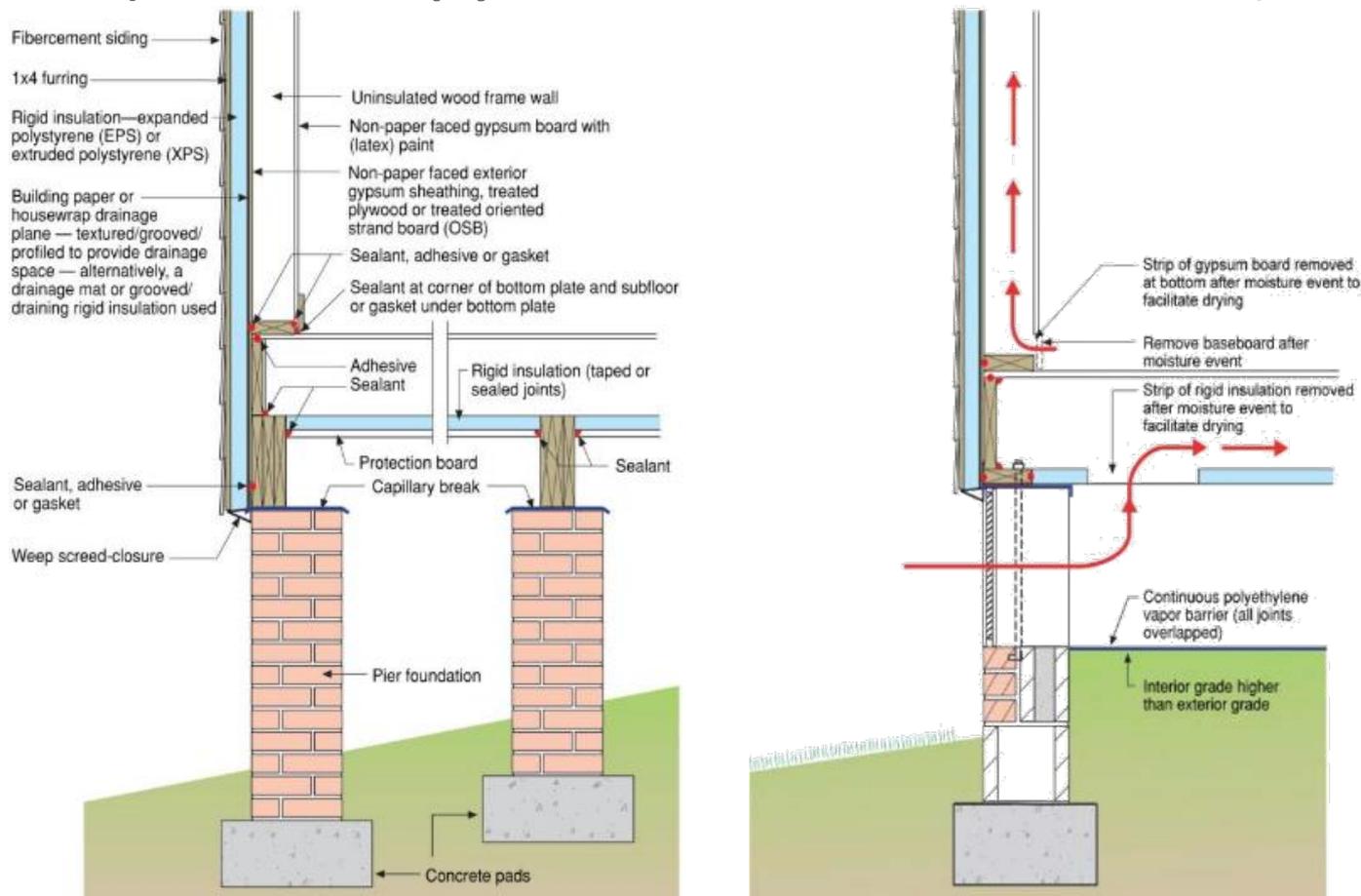


- **Flood-hardy** materials and building systems
- **Elevated** on piers to BFE +2
- **Wind connections**, sheathing for 130 mph
- **Termite-resistant** borate-treated lumber, plywood
- **Rain, moisture, air and thermal controls**
- **HVAC** for low energy and healthy home





Flood-Resilient, Wood Frame Building System (solid lumber, plywood & closed cell foam insulation)



Illustrations courtesy of
Building Science Corporation



Flood-Hardy Materials

solid lumber & plywood – no OSB or LSL in floor and walls



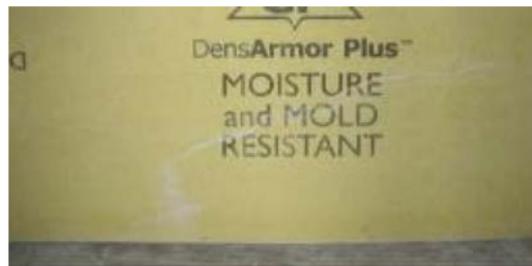


Flood-Hardy Materials

Paperless drywall w/ moisture resistant core – no mold food

Tile flooring

Fiber-cement siding and trim





Flood-Hardy Materials

GD 1: Fire rated rigid foam under floor joists, sealed airtight

GD 2: Closed cell spray foam between floor joists, rim



GD 1



GD 2

Hot-humid Climate

***Raised Floors
rot and cup
in the summer!***



**Cool A/C
+ impermeable flooring
+ permeable insulation**

-  **wet subfloors**
-  **cupped wood flooring**
-  **mold and decay fungi**
-  **termite attraction**





Flood-Hardy Materials & Drainable Assemblies

GD 1: 2.5" closed cell spray foam in wall cavities – partial fill

GD 2: 2" rigid Iso foam board outside sheathing & wrap



GD 1



GD 2



GD2: WRB AND Drainage Gap



1. Housewrap over plywood

2. Insect screen draped over bottom flashing



3. Foil-faced 2" rigid foam board over housewrap

4. Furring strips over foam board, screen wrap insect excluder



5. Trim out window wells

6. Fiber-cement siding, trim



New Flood-hardy wood-frame building system

(Source: Building Science Insights 101 – *Rebuilding Houston*)

- **XPS sheathing + CC foam**
 - No wood sheathing
- **CC foam provides racking resistance**
- **Washable, drainable, dryable**
- **Added R-value**

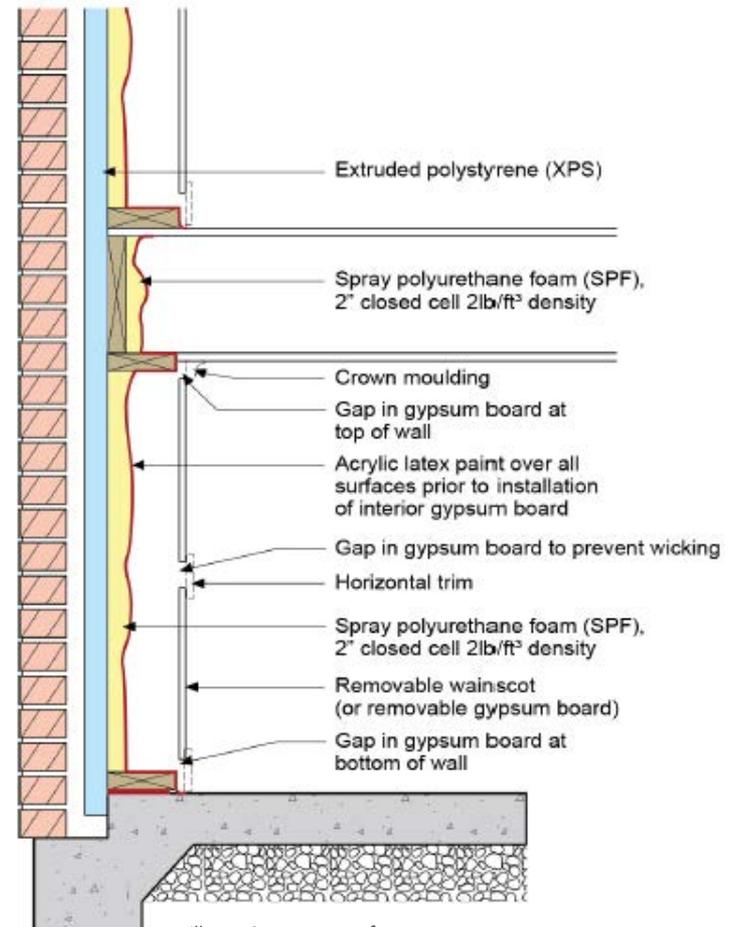


Illustration courtesy of Building Science Corporation



Now what about restoring flooded homes?

www.LSUAgCenter.com/LaHouse

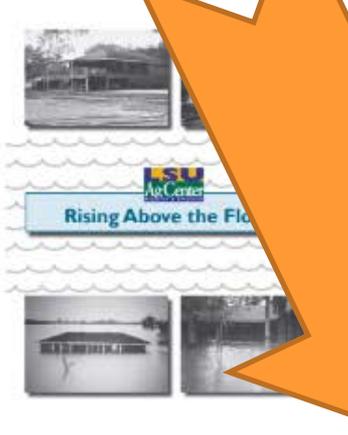
Flood Recovery Resources



Disaster Information
Storm Damage Cleanup Highlights
 How do we begin to clean up after a disaster? First, you need to know what you're dealing with. The LSU AgCenter provides a comprehensive guide to help you understand the scope of the damage and the steps you need to take to get your home back in shape.



Wet Floodproofing: Reducing Damage from Floods
 The phrase "wet floodproofing" may sound like a contradiction, but it's a key strategy to reduce the damage of fast-rising water in a building when flooding occurs.



Rising Above the Flood
 Rising above the flood means more than just staying above the water. It means taking the time to plan and invest in flood-resistant construction techniques that can help you protect your home and belongings.



[Storm Damage Cleanup Highlights](#)

[Wet Floodproofing](#)

[Disaster Information](#)

[FAQ's - After Gutting Your Flooded Home](#)

Innovate . Educate . Improve Lives

The LSU AgCenter and the LSU College of Agriculture



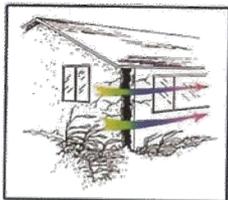
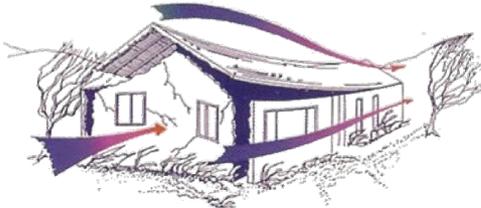
3 Flood Restoration Methods





Hurricane Resistance, Resilience, Recovery

External Pressures



Internal Pressures

Turn it upside down and shake it.



Hurricane Damages

The major building envelope issues:

1. Loss of roof cover
2. Loss of roof sheathing
3. Debris impact – large holes via broken windows and doors
4. Window and door anchorage, connections, and pressure ratings
5. Garage doors & sliding glass doors
6. Water leakage
7. Ridge vents, gable vents and soffits





Hurricane-Hardy Roof

Plywood decking, ring shank nails, 6 in. spacing

Adhesive underlayment (*secondary moisture barrier*)

Class H (150-mph) wind-rated, Class 4 hail-rated shingles





Attic Vents and Soffits

Risky

- Gable vents
- Turbine vents
- Power vents
- Standard ridge vents
- Vinyl, aluminum soffit vents, esp. in J-channel

Safer

- TSA 100 wind-tested ridge vents with water barrier
- Structural soffits
 - Perforated fiber cement
 - Plywood w/ fastened soffit vent
 - Baffle at top plate
- Unvented attic system
 - No vents, so no wind driven rain
 - CC foam adds deck adhesion plus shear load capacity

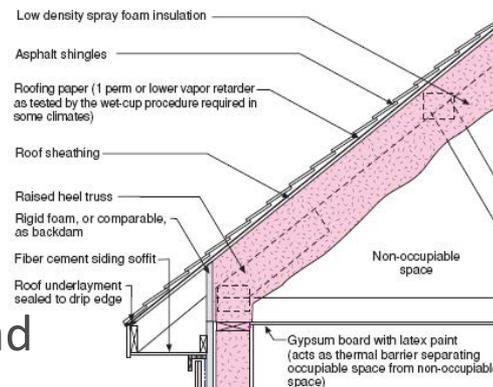
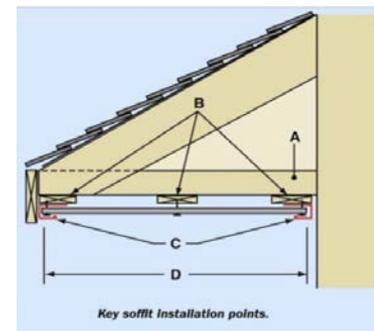
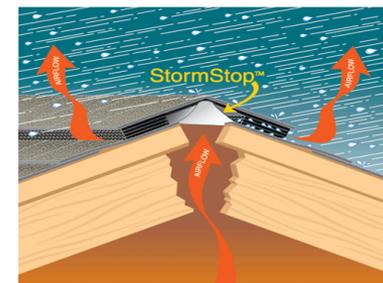


Figure 8
 Air Impermeable Spray Foam Insulation



Hip Roof with moderate slope

Aerodynamic + sheds water away + shades all sides

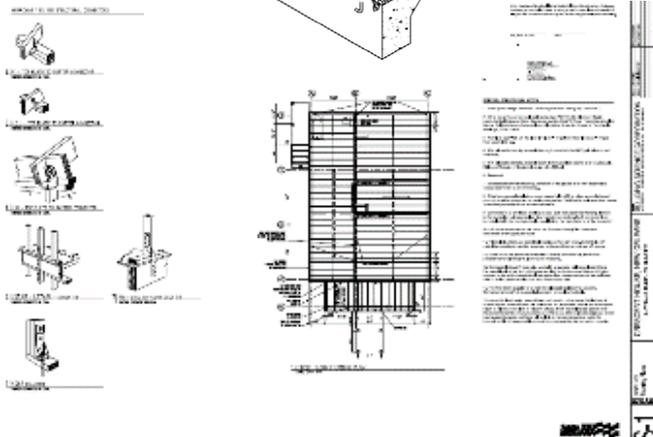
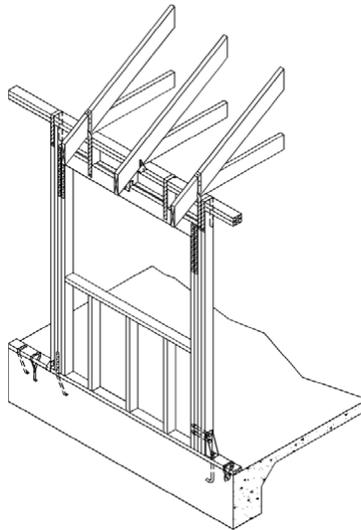
Continuous Sheathing to resist racking

Blocking at seams so all edges nailed to framing





Continuous Load Path from roof to foundation

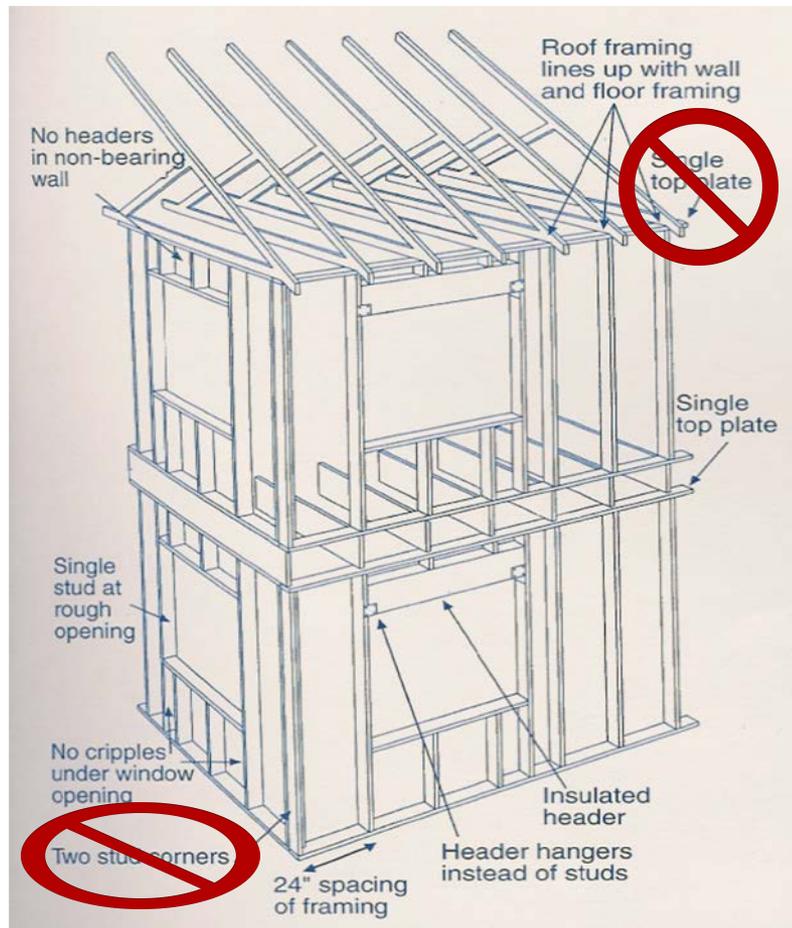




Advanced Framing
(2x6, 24 o.c.)
More insulation
Less lumber
Stack Framing
Easier Connections
Low cost

Modified for high wind:

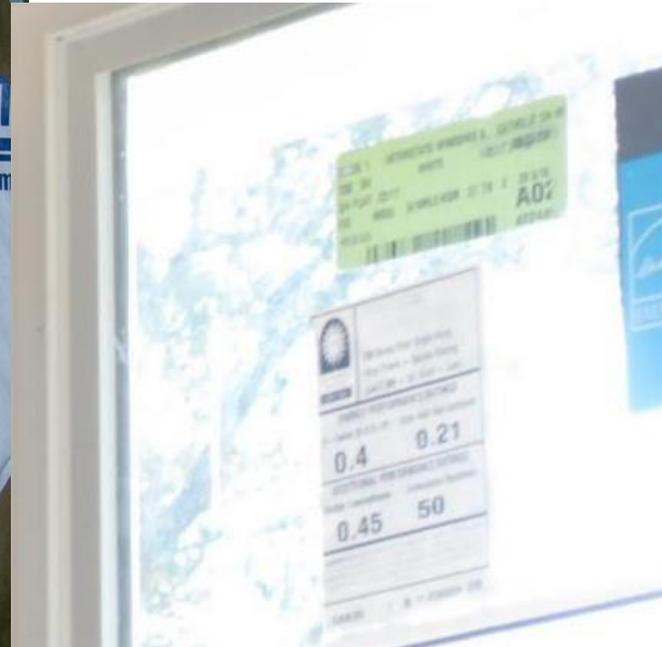
- **Double top plates**
- **3-stud corners**



Reproduced with permission from Building Science Corporation



Impact Rated, High Design Pressure, Energy Star Windows and Doors



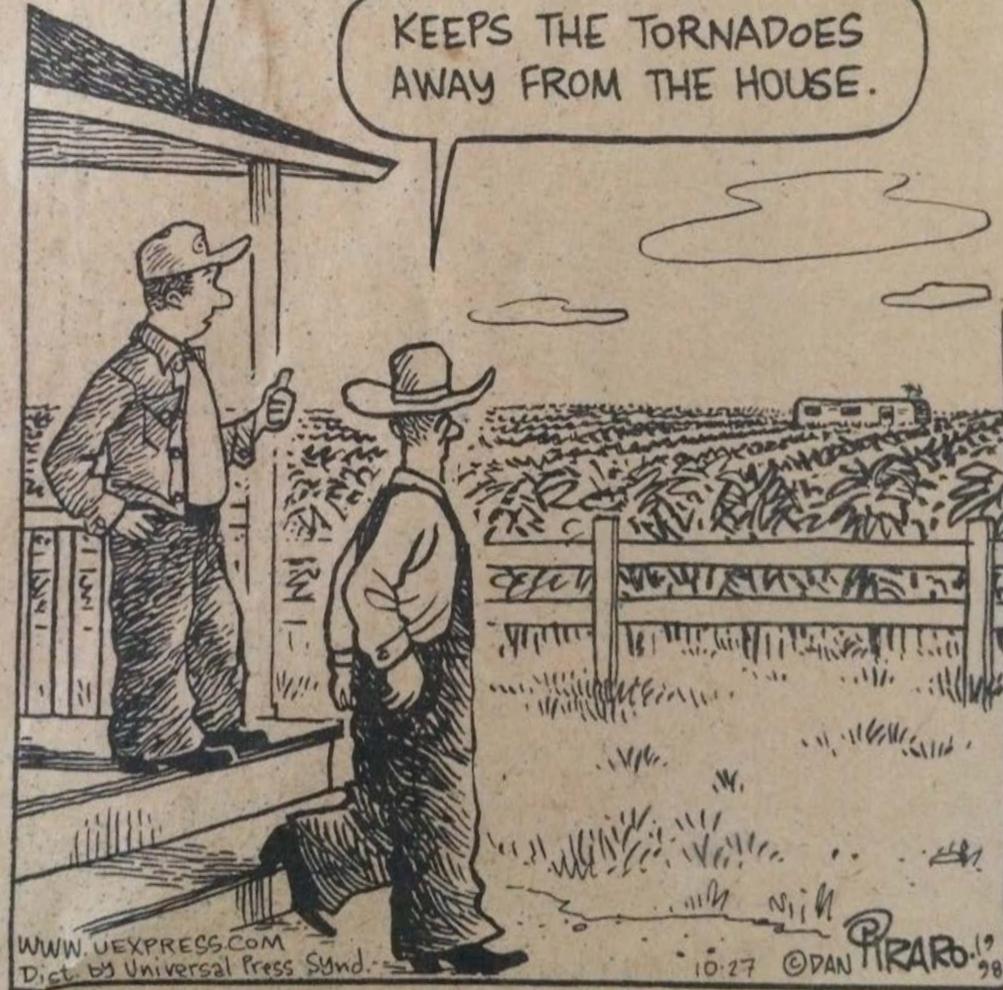
Tornados



Bizarro by Dan Piraro

Why do you got an abandoned mobile home in the middle of your cornfield?

KEEPS THE TORNADOES AWAY FROM THE HOUSE.

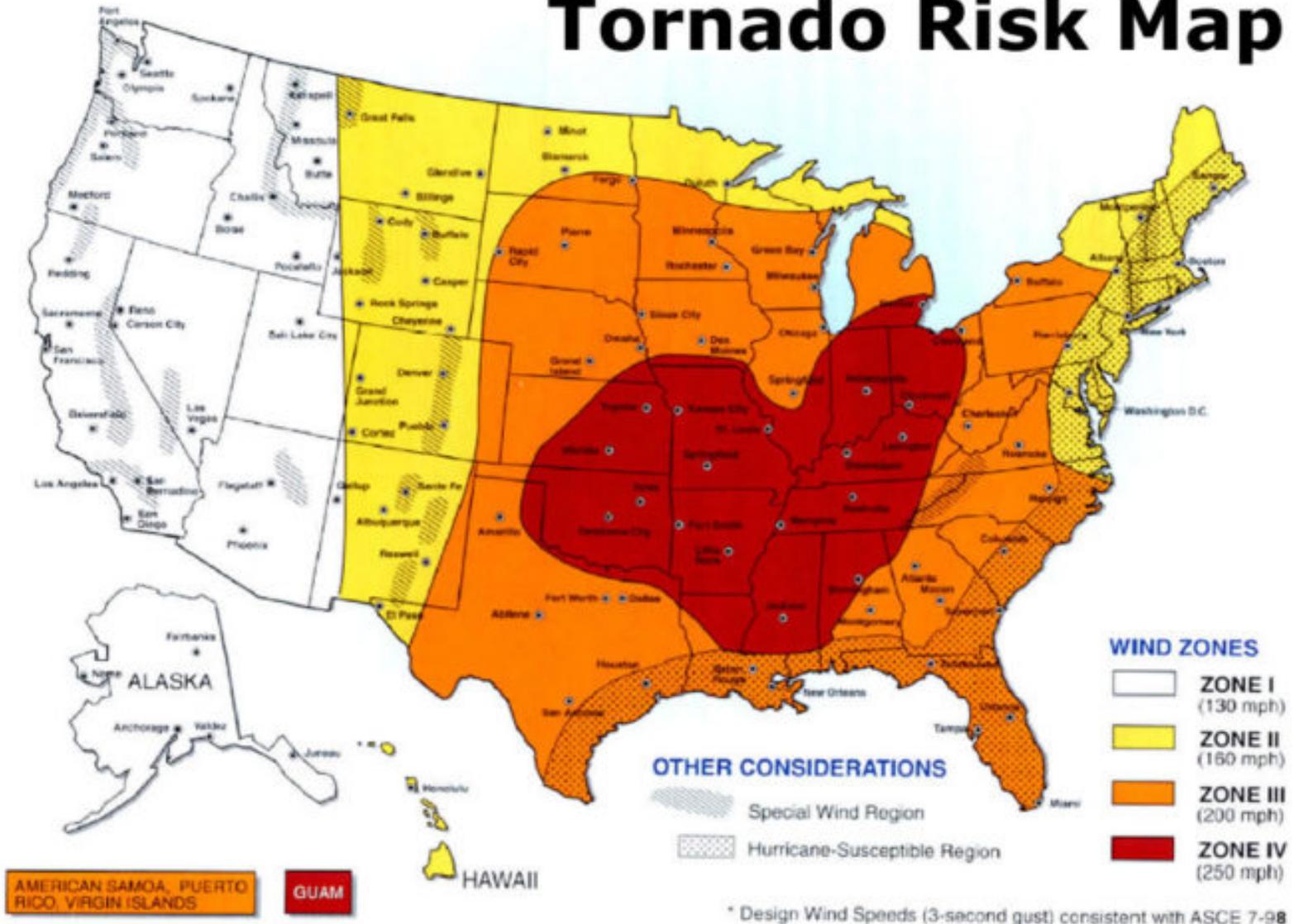


WWW.UEXPRESS.COM
Dict. by Universal Press Synd.

10-27 © DAN PIRARO 1998

Tornados

Tornado Risk Map

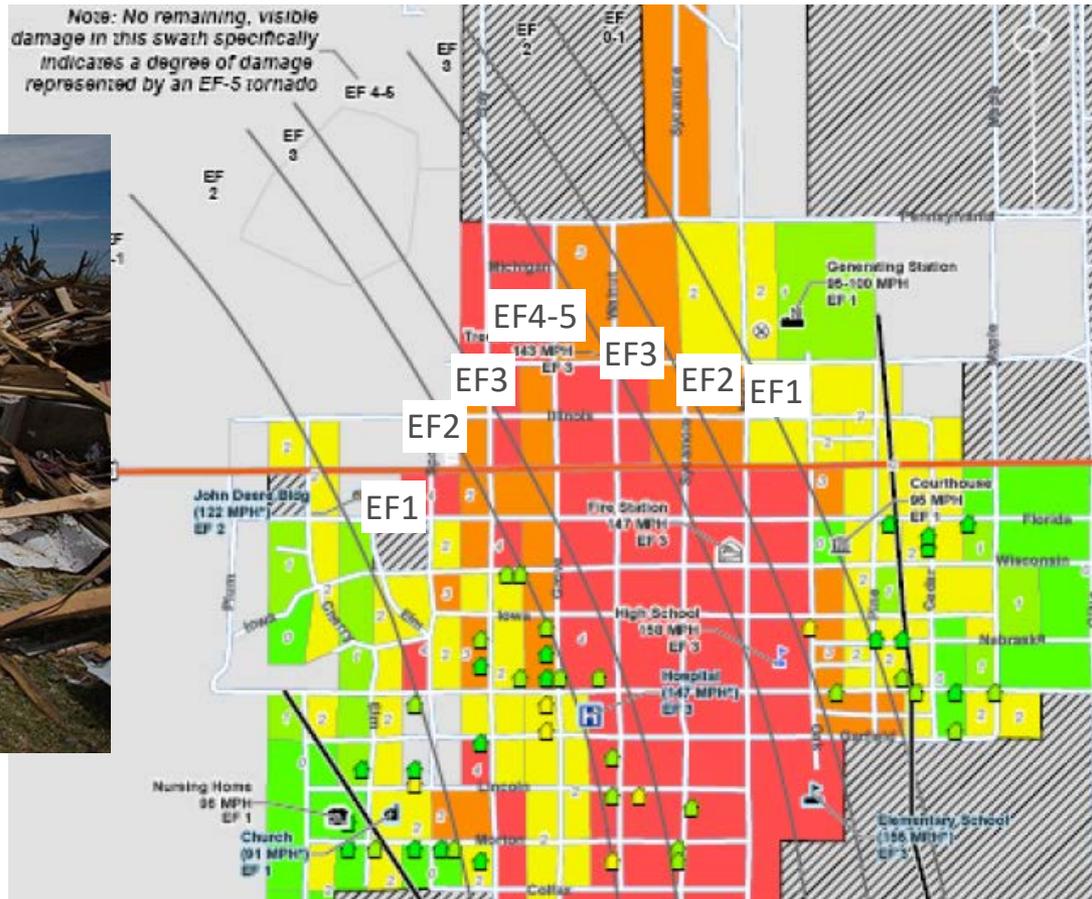


High Wind Designs Cover Most Tornadoes

Wind designs for building code in hurricane areas will protect from nearly all tornadoes EF3 and lower.

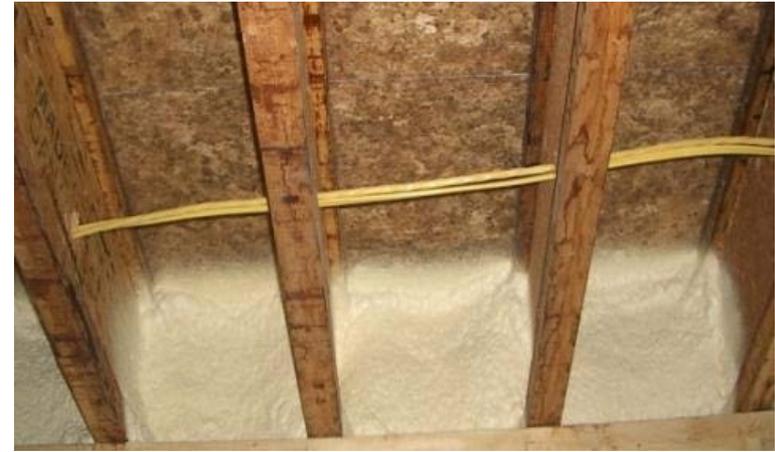


© Mike Theiss UltimateChase.com



Spray Foam Insulation in New Construction

- ▶ Seals and Insulates unvented attics.
- ▶ Seals and Insulates wall cavities and rim joists.
- ▶ Foam must be thick enough to avoid condensation.

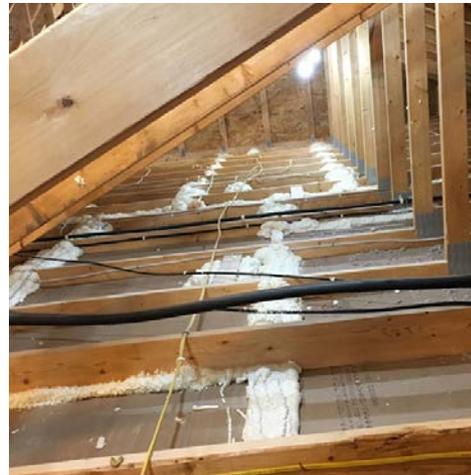


Spray Foam Insulation in Retrofits

- ▶ Seal roof framing to underside of roof deck with two-part, cc polyurethane spray foam or AFG-01-rated adhesive.*
- ▶ Increases wind-uplift resistance of pre-1994 code-minimum wood roof panels by **250%–300%**.**
- ▶ Air seals and increases integrity of ceiling deck.



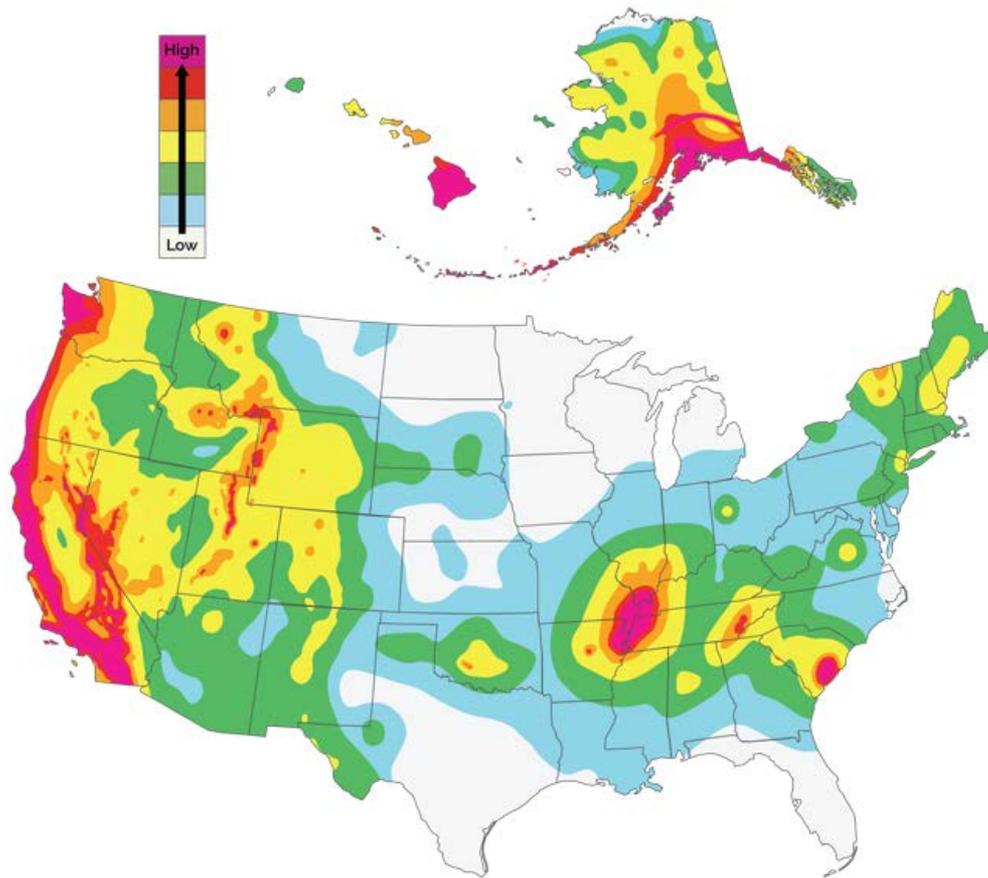
Photo courtesy of FEMA 2010.



*FEMA. 2010. FEMA P-804/December 2010

**Datin et al. 2011. Journal of Architectural Engineering

Earthquake Resistance, Resilience, Recovery via SIPS



Are you building in an area at high risk for earthquakes?

6 SIPS homes withstood the "Great Hanshin" earthquake in Kobe, Japan, in 1995.

Structural Insulated Panel Systems achieved Class 6 Seismic Designation, the highest designation for building materials in the State of California.



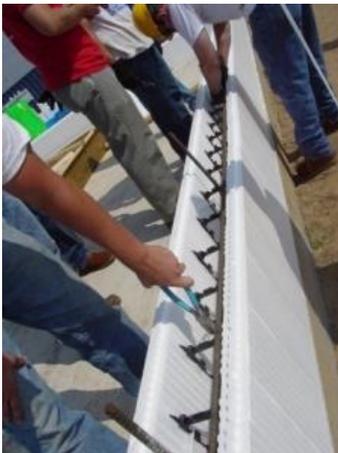
Structural Insulated Panel System (SIPS)

Airtight seams, truly continuous insulation (no studs),
High racking resistance via 2 sheathing panels



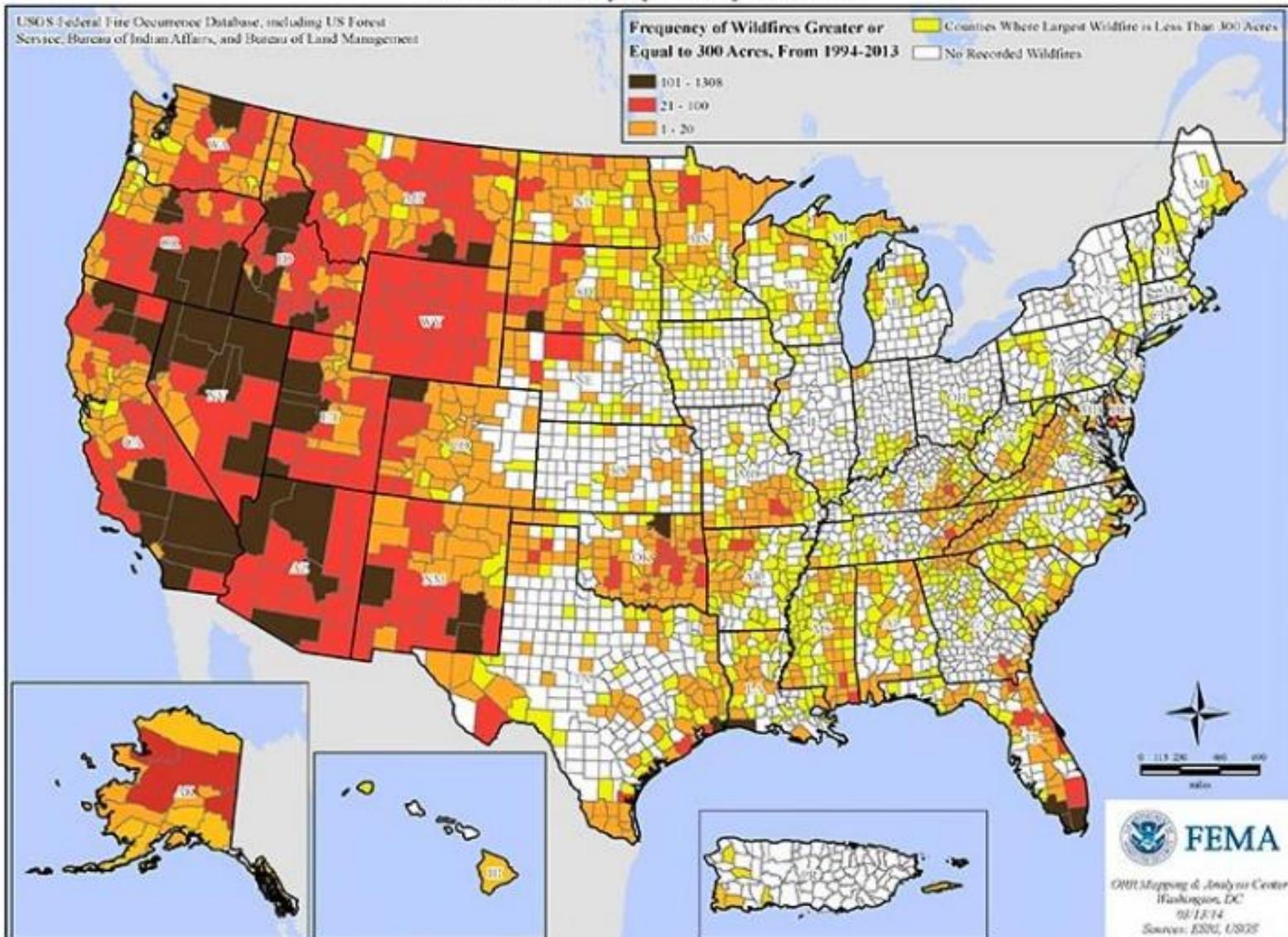
Insulating Concrete Forms (ICF)

Steel reinforced concrete core
High R, continuous insulation



Wildfire Resistance, Resilience, Recovery

Wildfire Activity by County 1994-2013



Wildfire Protections

to resist wind-blown embers

1. Roof:

- Class A rated roofing system
- ¼" wire mesh on vents
- Birdstops, gutter leaf guards

2. Design does not hold debris

3. Walls:

- Non-combustible finishes
- Steel doors
- Tempered, dual-glaze, low-e glass

4. Decks, porches, fencing

- UBC fire-retardant material
- Cement plaster undersides

5. Landscape buffer zone > 5 ft.

- Non-combustible mulch, etc.

Top 10 Ways to Protect Your Home from Wildfire



Learn more at DisasterSafety.org/Wildfire



IBHS Study: Ember Intrusion through Gable and Eave Vents



Gable Vents

©Insurance Institute for Business and Home Safety



Soffit Vents

©Insurance Institute for Business and Home Safety

Vulnerability of Roof Vents to Wind-Blown Embers

Limit Ember Entry

- >2 million homes in CA have high-to-extreme risk for wildfire damage.
- Embers can enter thru soffit and gable vents.
- Avoid gable-end vents if possible.
- Use wildfire-resistant gable, soffit, and ridge vents plus mesh screen that is less than ¼-in.
- Keep vents clean.
- Better yet, design homes with unvented attics.



Unvented Attics improve resilience and save energy

Multi-Hazard Resilience

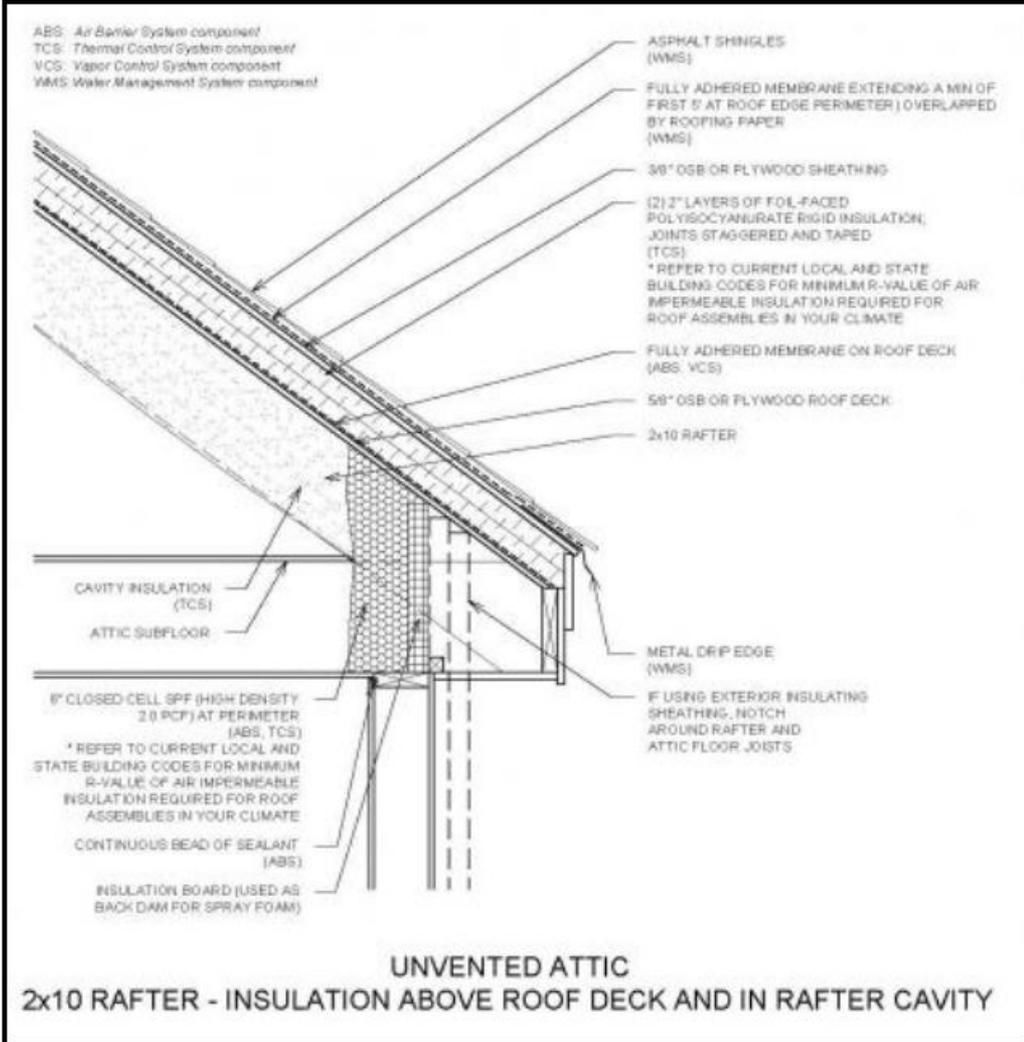
- Keep out burning embers.
- Keep out wind-blown rain.
- Reduce wind uplift pressures.
- Keep out bugs, birds, bats, and other varmints.

Energy Benefits

- Provide conditioned space for HVAC (and storage).
- Move thermal boundary above ceiling penetrations for electrical, HVAC, can lights, exhaust fans...
- Reduce the stack effect.
- Simplify air sealing and insulating of attic kneewalls.

Both

- Keep out humid air.
- Minimize ice dam formation.



“Unvented attics make a lot of sense.”

Joe Lstiburek, Building Science Corporation.

Disaster Recovery Reform Act of 2018

\$1



\$6

Every \$1 invested
in mitigation
activities.

saved in future
disaster costs,
nationally



National Institute of
BUILDING SCIENCES

Ride out the Storm in a High-Performance Home



ICF "Igloo" in Upstate New York
Winter 2017 - Severe cold, Four-day power outage
Outside: -8 to +16°F
Inside: + 56°F - with no heat source in house

Ride out the Storm in a High-Performance Home



1.89 kW of PV plus a 10-kW battery covers nearly all of the homes energy needs.

Ride out the Storm in a High-Performance Home



Ride out the Storm in a High-Performance Home



Mountain Home
7,600 feet elev.
Durango, CO

World-Class Best Practices...



Michael Baechler: michael.baechler@pnnl.gov
Theresa Gilbride: theresa.gilbride@pnnl.gov
Chrissi Antonopoulos: chrissi.antonopoulos@pnnl.gov

Building America
Solution Center
BASC.energy.gov

...At Your
Fingertips

Thank you!

Theresa Gilbride, Theresa.Gilbride@pnnl.gov

Claudette Hanks Reichel, Creichel@agcenter.lsu.edu

Hunter Mantell-Hecathorn, hunter@m-hbuilders.com