Wall System Options

April 8, 2005

Building AMERICA U.S. Department of Energy

Wall Design Theory

- Prevent assemblies from getting wet from the outside
- Prevent assemblies from getting wet from the inside
- Should assemblies get wet or start out wet, allow them to dry to the interior, exterior, or both

Ideal Wall Construction

- Build with dry materials
- Allow no water to get into the assemblies during construction
- Dry any assemblies or elements that get wet prior to closing up

Definition of a Moisture Problem

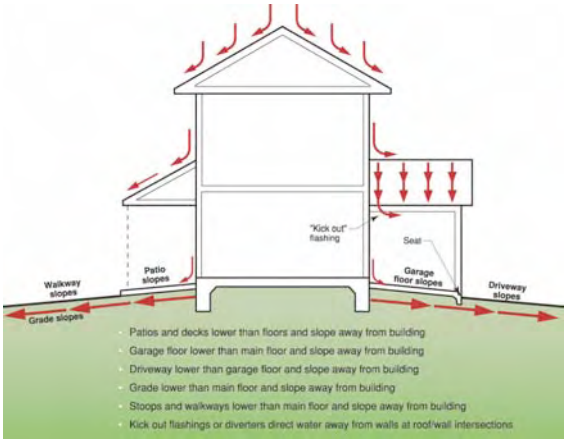
- It's a rate issue, that is, when the rate of wetting is greater than the rate of drying accumulation occurs.

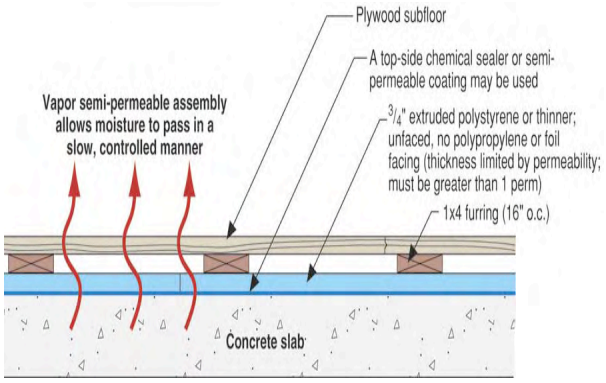
- Problems don't occur until the quantity of accumulated moisture exceeds the moisture storage capacity of the material, system or assembly.

- The moisture storage capacity is specific
  - time
  - temperature
  - material

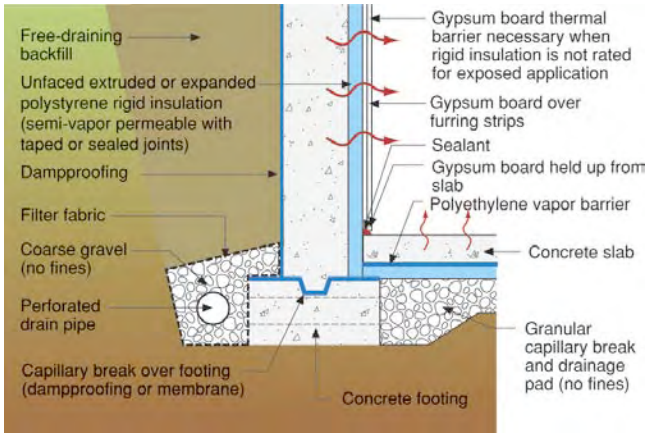
Hygric Balance

- How Buildings Get Wet
  - From the outside
  - From the inside
  - Start out wet





- How Buildings Dry
  - Dry to the Outside
  - Dry to the Inside



April 8, 2005

Building America SM
U.S. Department of Energy

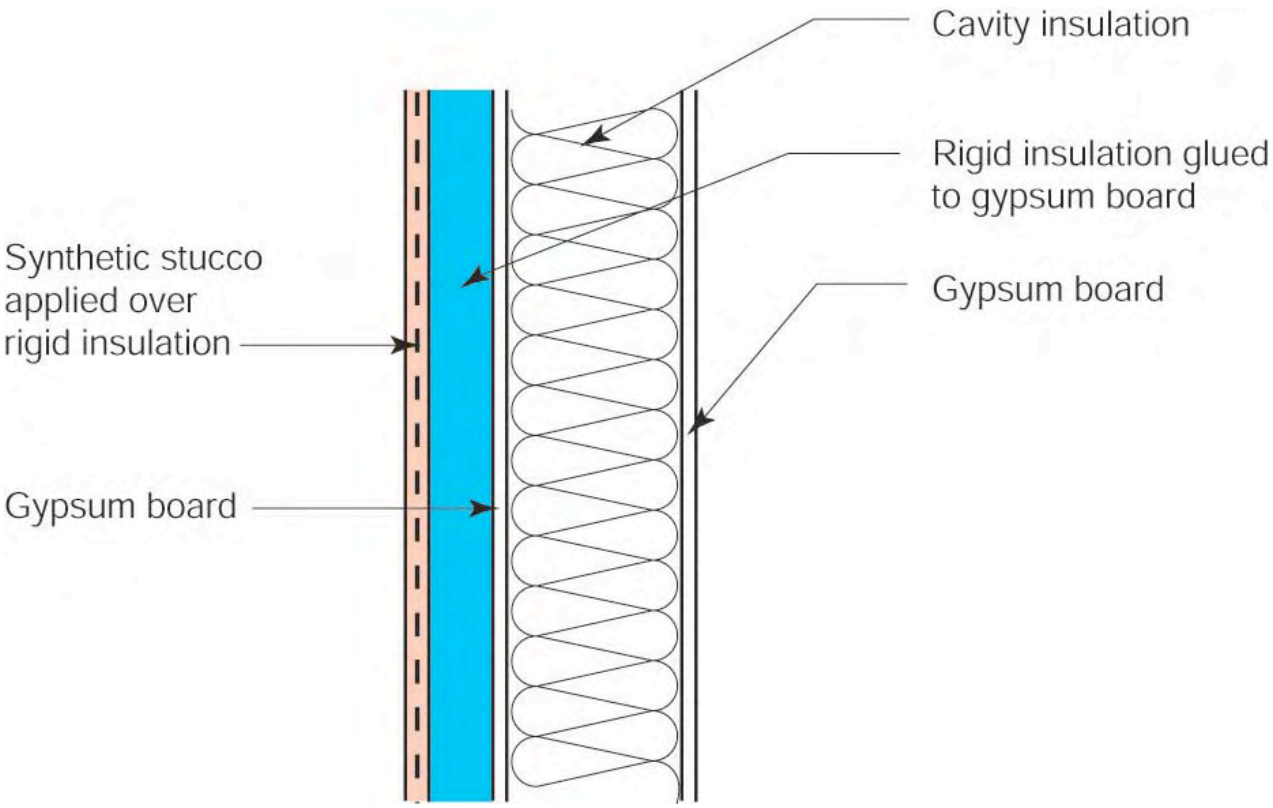
1. Why Drainage Planes are Required

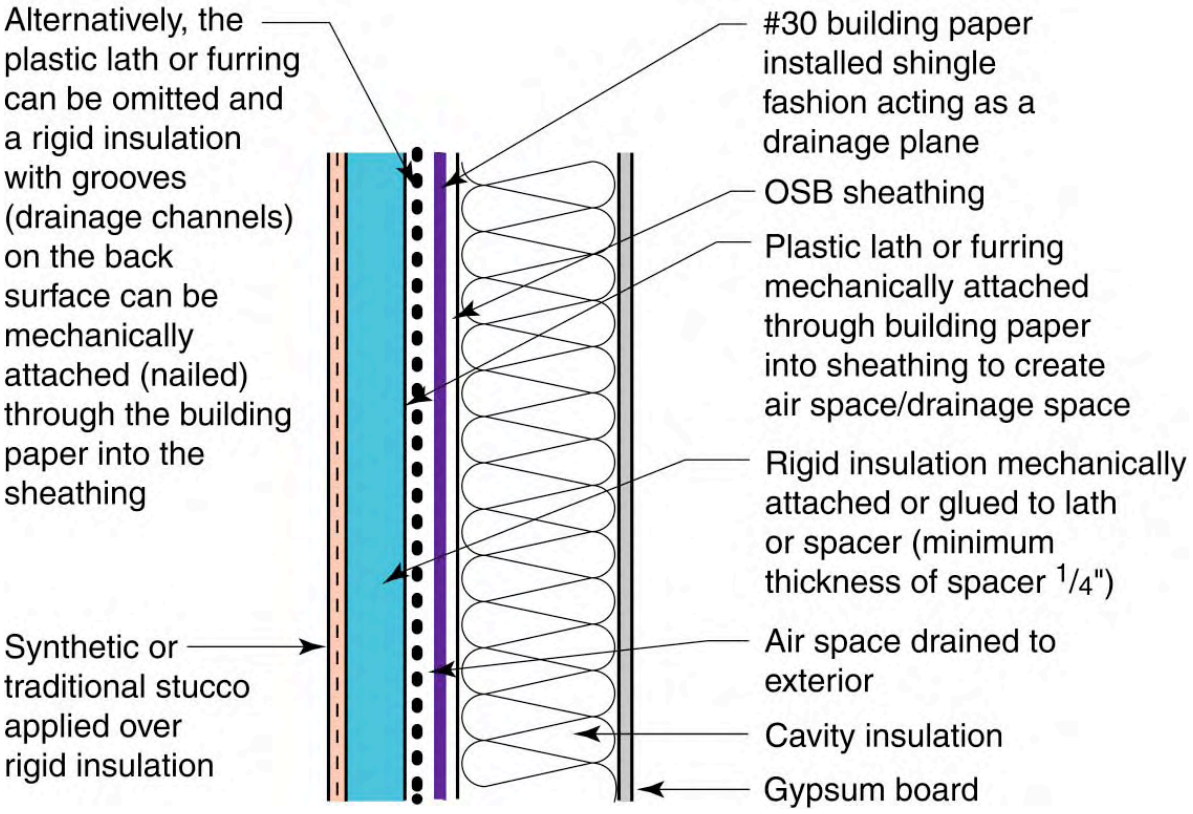
&

How Plastic Vapor Barriers are Keeping Assemblies Wet Rather than Preventing Them From Getting Wet

April 8, 2005

Building AMERICA U.S. Department of Energy


Cavity insulation
Rigid insulation glued to gypsum board
Gypsum board
Synthetic stucco applied over rigid insulation
Gypsum board


Alternatively, the plastic lath or furring can be omitted and a rigid insulation with grooves (drainage channels) on the back surface can be mechanically attached (nailed) through the building paper into the sheathing
#30 building paper installed shingle fashion acting as a drainage plane
OSB sheathing
Plastic lath or furring mechanically attached through building paper into sheathing to create air space/drainage space
Rigid insulation mechanically attached or glued to lath or spacer (minimum thickness of spacer 1/4")
Synthetic or traditional stucco applied over rigid insulation
Air space drained to exterior
Cavity insulation
Gypsum board

Exterior Conditions

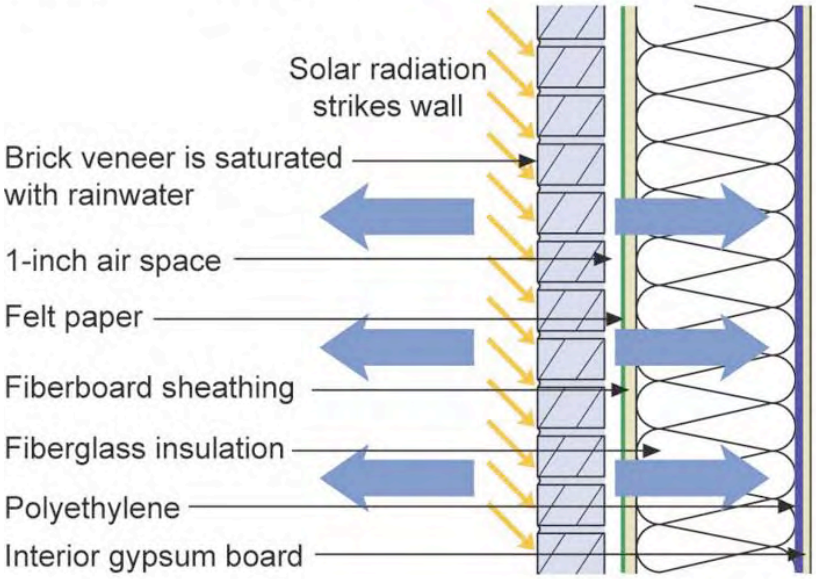
Temperature: 80°F
Relative humidity: 75%
Vapor pressure: 2.49 kPa

Conditions within Cavity:

Temperature: 100°F
Relative humidity: 100%
Vapor pressure: 6.45 kPa

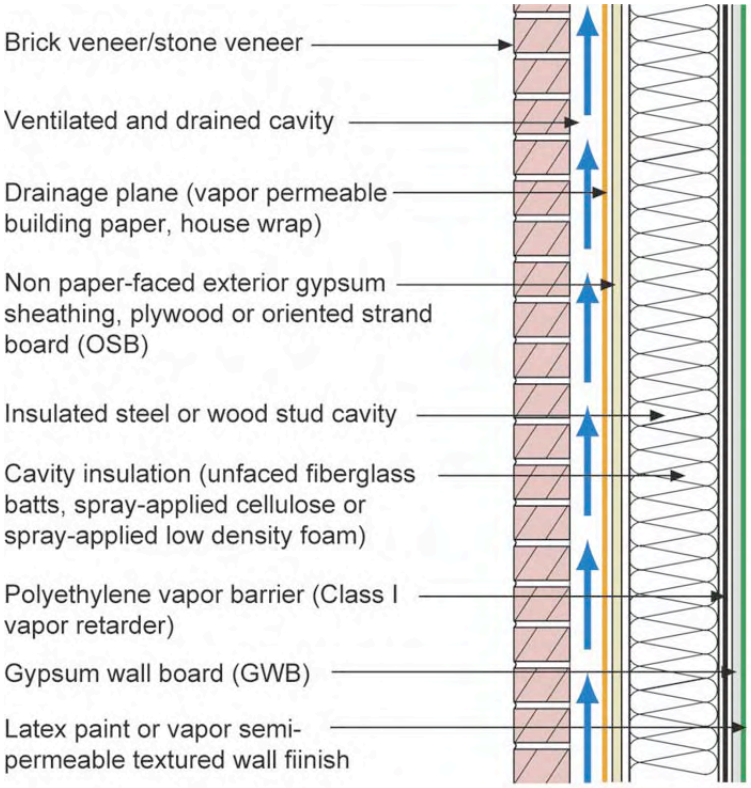
Interior Conditions

Temperature: 75°F
Relative humidity: 60%
Vapor pressure: 1.82 kPa



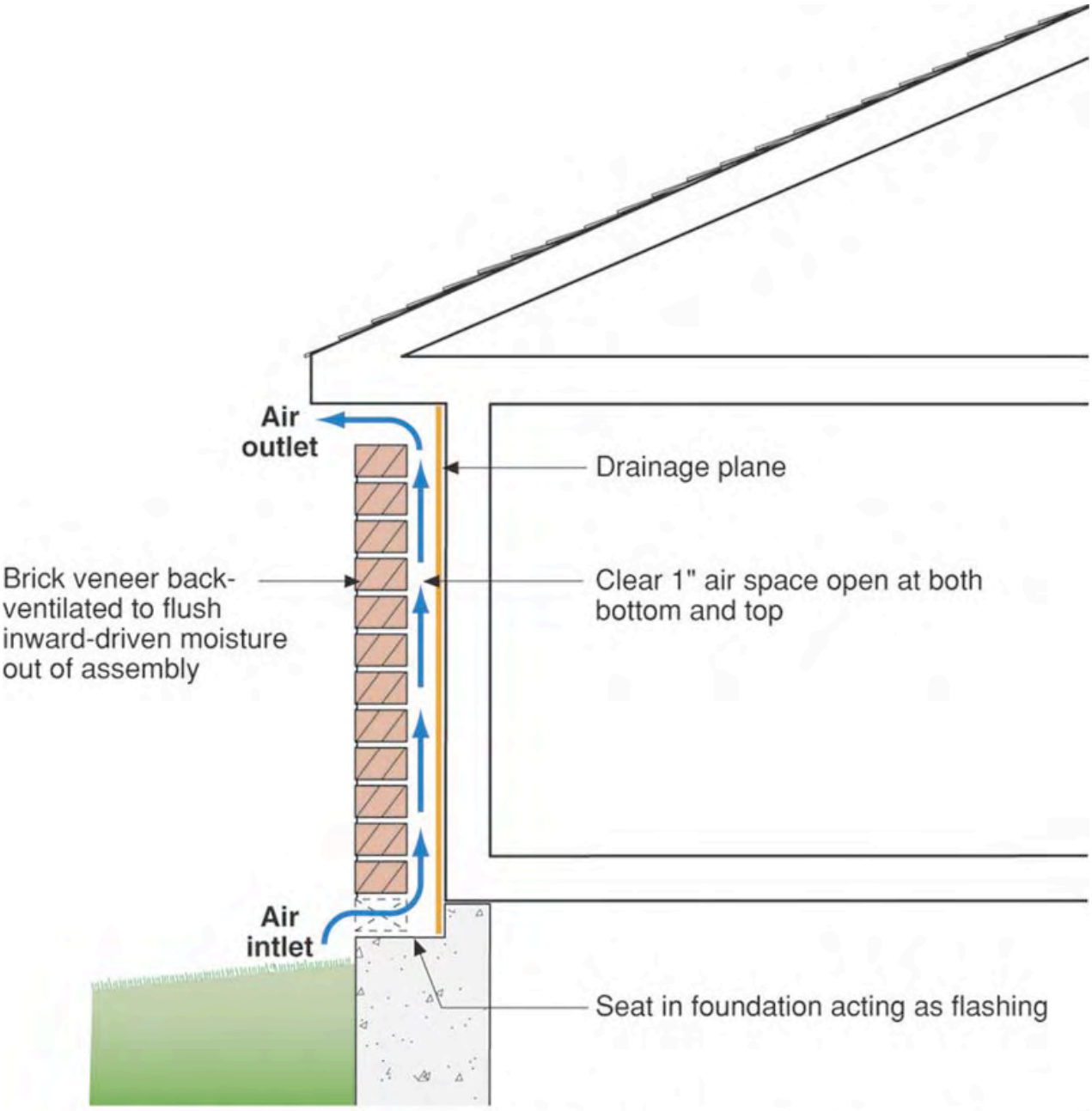
Vapor is driven both inward and outward by a high vapor pressure differential between the brick and the interior and the brick and the exterior.

- It is not a good idea to install a vapor barrier (polyethylene) on the inside of an air conditioned assembly. Vinyl wall coverings and foil-backed batt cavity insulation should also be avoided.
- Vapor permeable exterior sheathings, housewraps or building papers should not be used with absorptive claddings such as brick veneers unless a ventilated cavity is provided in conjunction with high inward drying potentials (i.e. no interior polyethylene vapor barriers).
- Failure will occur when brick is installed over a frame wall constructed with felt paper, fiberboard sheathing and an interior polyethylene vapor barrier. Kraft-faced fiberglass batts should be used in place of unfaced batts and a polyethylene vapor barrier. OSB, plywood or foam sheathing should be used in place of the fiberboard sheathing.
- Similar problems occur with stucco.

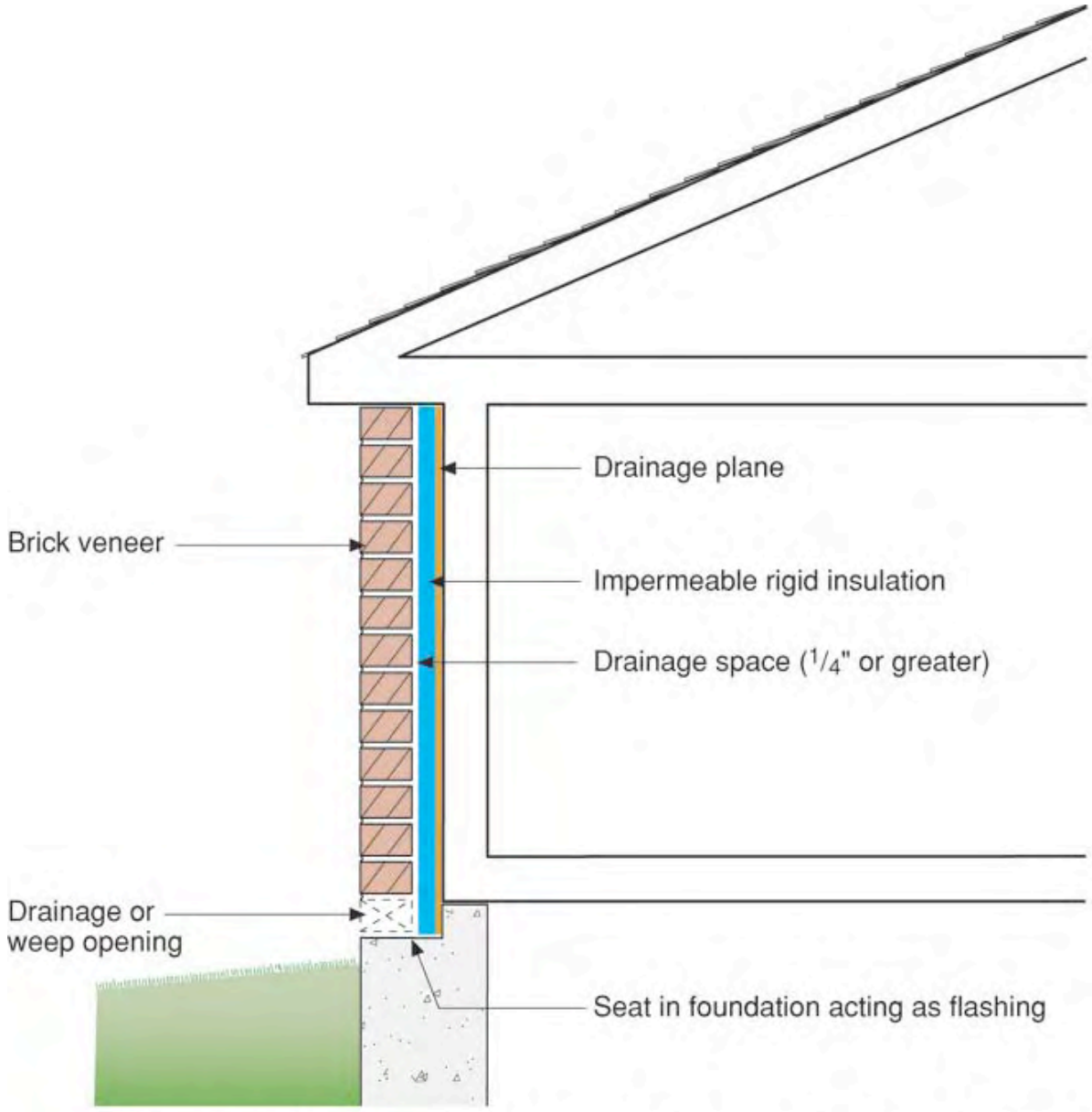

Brick veneer/stone veneer
Ventilated and drained cavity
Drainage plane (vapor permeable building paper, house wrap)
Non paper-faced exterior gypsum sheathing, plywood or oriented strand board (OSB)
Insulated steel or wood stud cavity
Cavity insulation (unfaced fiberglass batts, spray-applied cellulose or spray-applied low density foam)
Polyethylene vapor barrier (Class I vapor retarder)
Gypsum wall board (GWB)
Latex paint or vapor semi-permeable textured wall fiinish


Rboard
Rboard
Celotex

April 8, 2005



- To effectively uncouple a brick veneer from a wall system by using back ventilation, a clear cavity must be provided along with both air inlets at the bottom and air outlets at the top



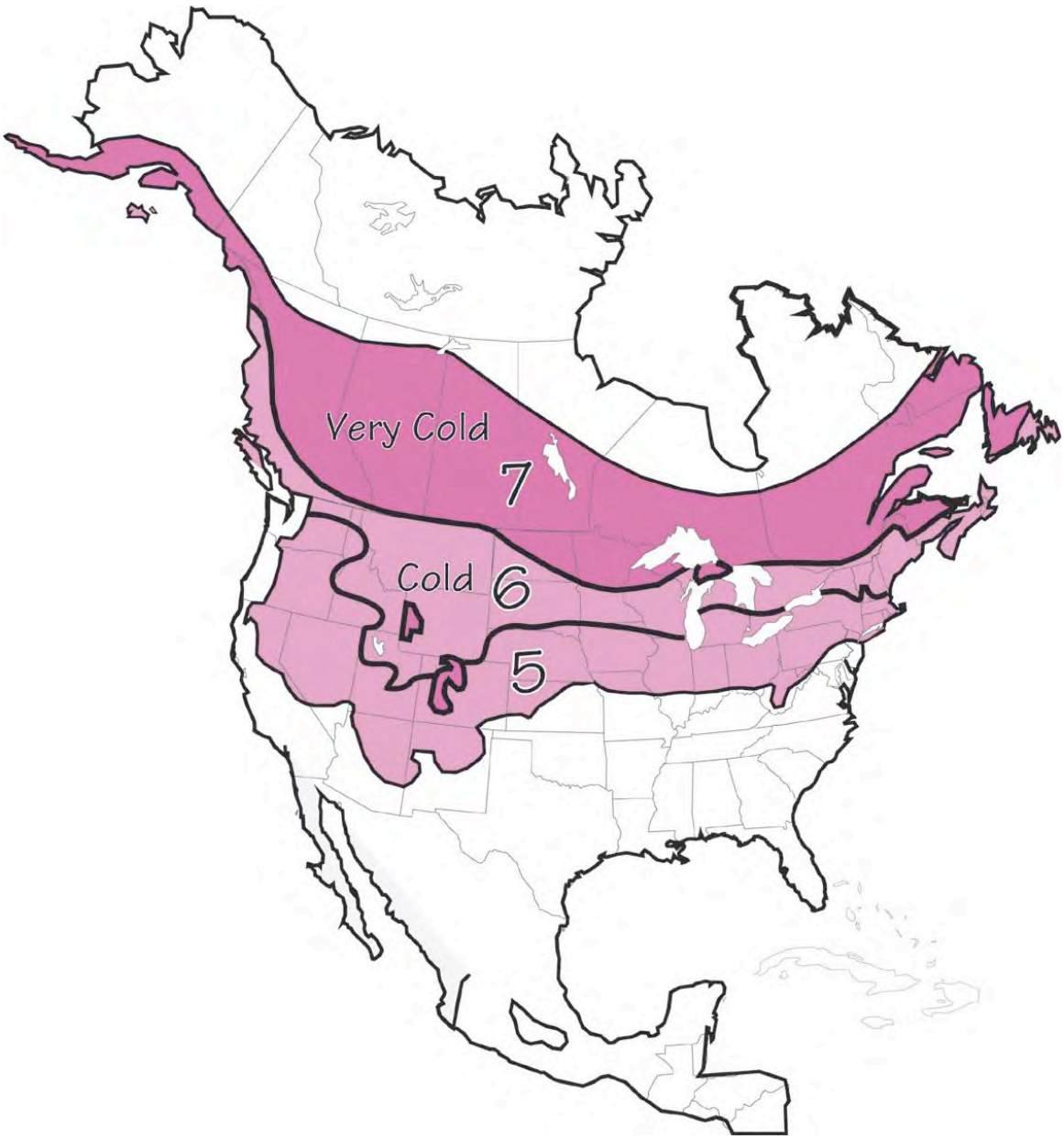
- To effectively uncouple a brick veneer from a wall system by using a condensing surface, the drainage plane must also be a vapor barrier or a vapor impermeable layer (i.e. rigid insulation) must be installed between the drainage plane and the brick veneer. Alternatively, the rigid insulation can be configured to act as both the drainage plane and vapor impermeable layer.
- When a condensing surface is used to uncouple a brick veneer from a wall system, a ventilated air space is no longer necessary — i.e. the presence of mortar droppings is no longer an issue. Additionally, the width of the drainage space is almost irrelevant.


PLUS
R3
PLUS
R3

April 8, 2005

April 8, 2005

Cold Climate
Hygro-thermal Zones



April 8, 2005

Vapor Retarder Classes

Class I

0.1 perms - Vapor Impermeable (Vapor Barrier)

Class II

1.0 Vapor Semi Impermeable

(greater than .1 and less than or equal to 1)

Class III

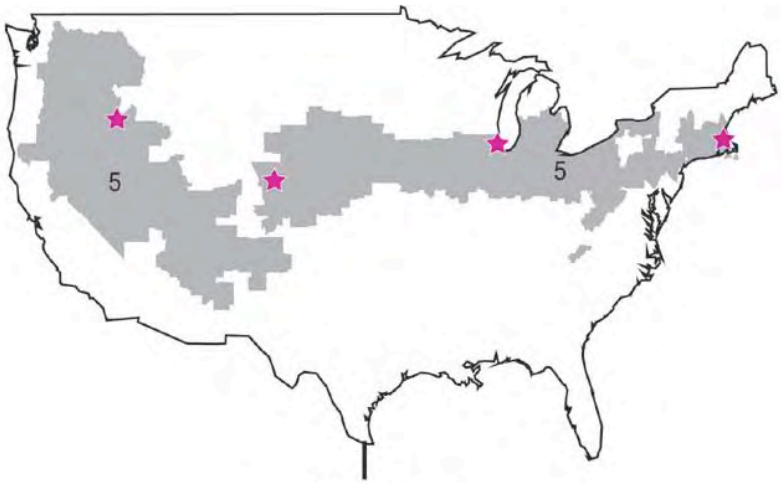
10.0 Vapor Semi Permeable

(greater than 1 and less than or equal to 10)

> 10.0 Vapor Permeable

April 8, 2005

Building AMERICA U.S. Department of Energy



Zone 5
(Chicago, Boston, Denver, Boise)

Sheathing/ cladding permeance (wet cup)

Over 1.0 perm (vapor semi-permeable) OSB, fiberboard, plywood

Class III (Paint)

Under/= 1.0 perm and over 0.1 perm (vapor semi-impermeable) Stucco, unfaced XPS 1" or greater

Class III (Paint)

with

Dewpoint test 30% RH (37°F dew pt.)

Class II (Kraft, SVR)

Under/= 0.1 perm (vapor impermeable) Foil polyiso

Class III (Paint)

with

Dewpoint test 35% RH (39°F dew pt.)

Class II (Kraft, SVR)

with

Dewpoint test 30% RH (37°F dew pt.)

Zone 6
(Minneapolis, Milwaukee, Burlington, VT)

Sheathing/ cladding permeance (wet cup)

Over 1.0 perm (vapor semi-permeable) OSB, fiberboard, plywood

Class II (Kraft, SVR)

Under/= 1.0 perm and over 0.1 perm (vapor semi-impermeable) Stucco, unfaced XPS 1" or greater

Class III (Paint)

with

Dewpoint test 25% RH (32°F dew pt.)

Class II (Kraft, SVR)

Under/= 0.1 perm (vapor impermeable) Foil polyiso

Class III (Paint)

with

Dewpoint test 30% RH (37°F dew pt.)

Class II (Kraft, SVR)

with

Dewpoint test 25% RH (32°F dew pt.)

Zone 7
(International Falls, Duluth, Aspen)

Sheathing/ cladding permeance (wet cup)

Over 1.0 perm (vapor semi-permeable) OSB, fiberboard, plywood

Class II (Kraft, SVR)

Under/= 1.0 perm and over 0.1 perm (vapor semi-impermeable) Stucco, unfaced XPS 1" or greater

Class III (Paint)

with

Dewpoint test 20% RH (28°F dew pt.)

Class II (Kraft, SVR)

Under/= 0.1 perm (vapor impermeable) Foil polyiso

Class III (Paint)

with

Dewpoint test 25% RH (32°F dew pt.)

Class II (Kraft, SVR)

with

Dewpoint test 20% RH (28°F dew pt.)

Bottom Line

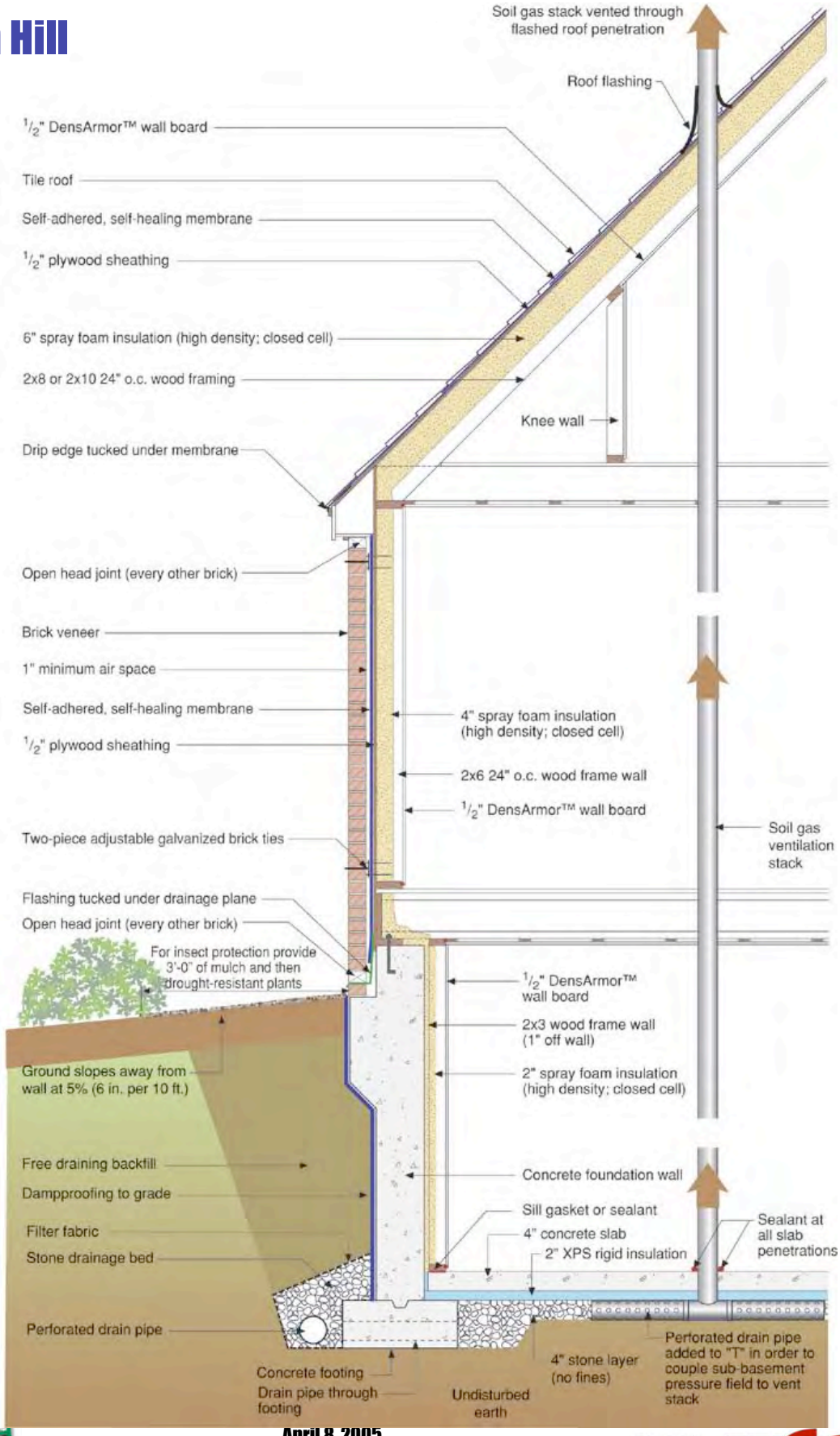
- Polyethylene makes very little sense to install on the inside of a wood frame wall except in very cold climates - and in most cases it is dangerous to install

- Vapor barriers should never be installed on the inside of air conditioned buildings

- Maps matter - if you want to design a building you actually have to know where you are

- The current code is dangerous - not because it is wrong, but because it is not clear enough to allow us to do the right thing without interference from the authorities who have jurisdiction

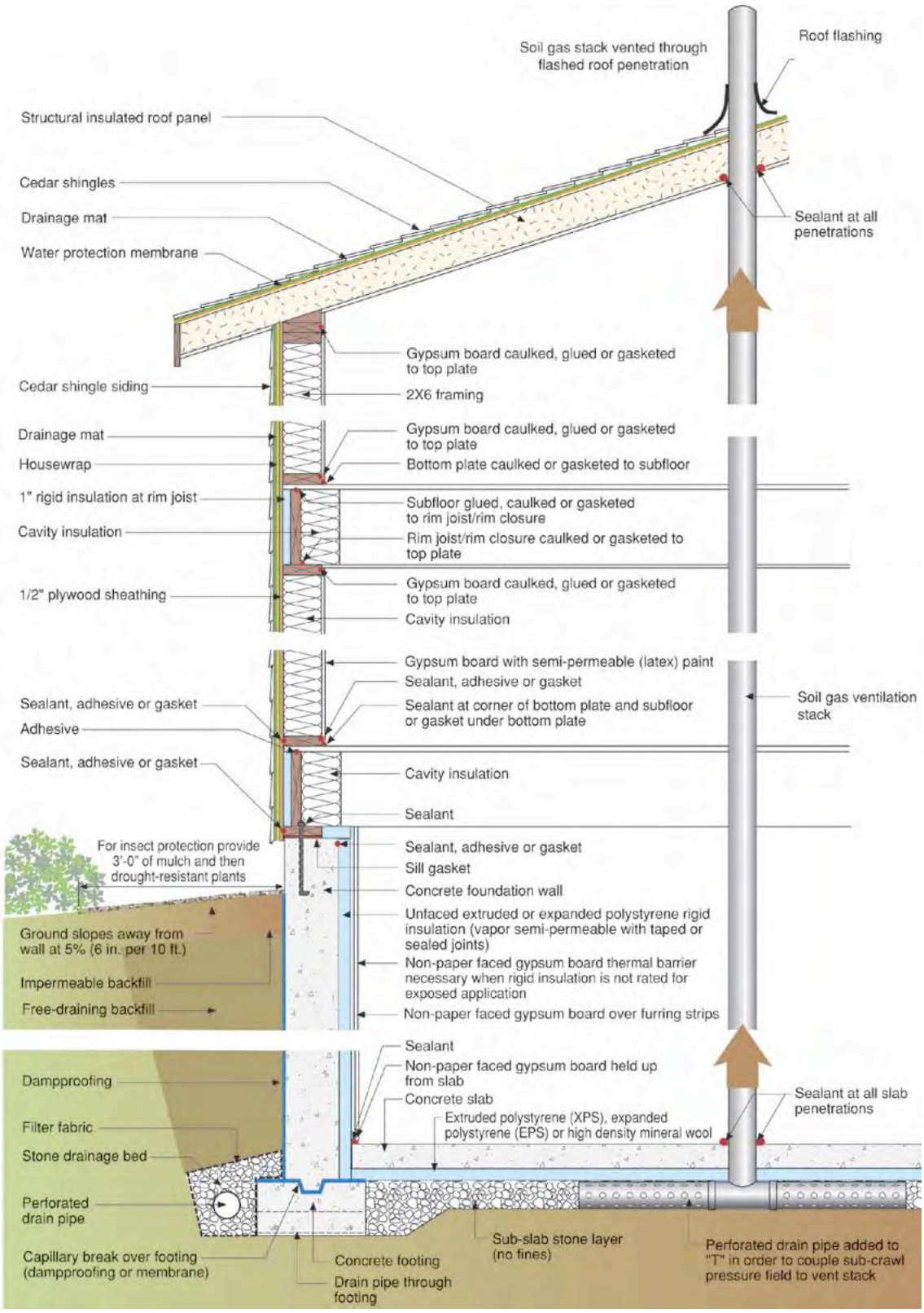
Beacon Hill



April 8, 2005

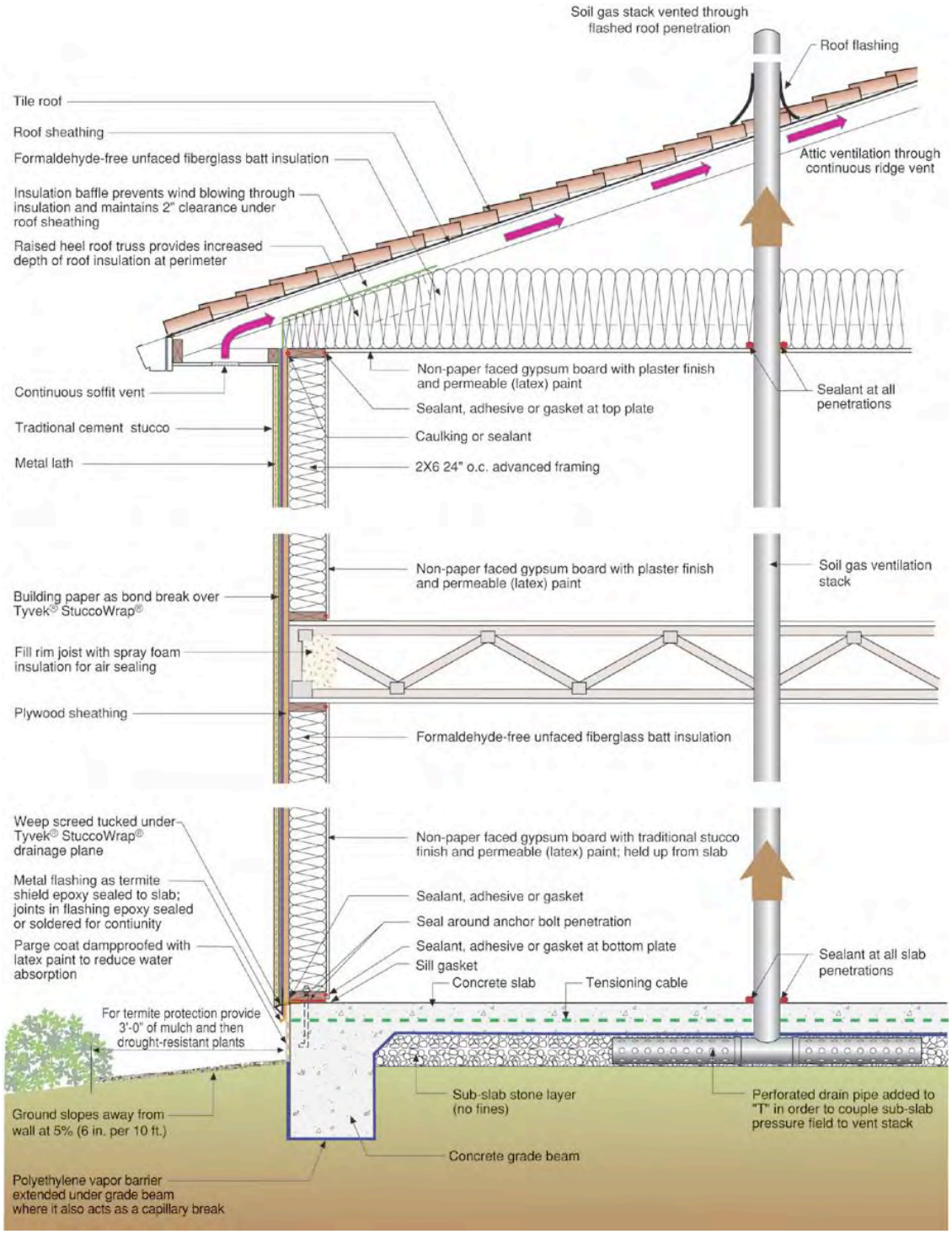
Building America U.S. Department of Energy

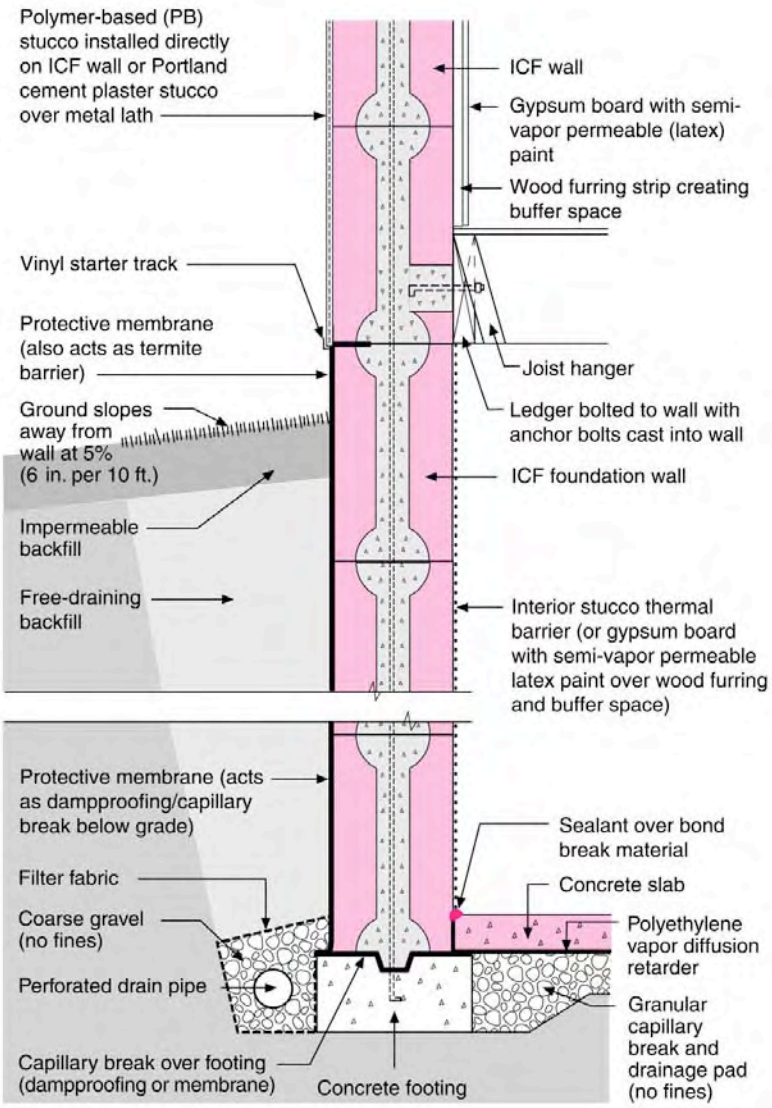
Martha's Vineyard



April 8, 2005

Montecito

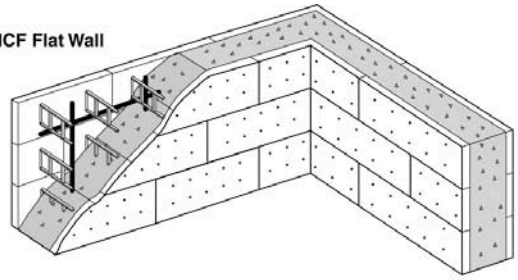

Soil gas stack vented through flashed roof penetration
Roof flashing
Tile roof
Roof sheathing
Formaldehyde-free unfaced fiberglass batt insulation
Insulation baffle prevents wind blowing through insulation and maintains 2" clearance under roof sheathing
Raised heel roof truss provides increased depth of roof insulation at perimeter
Attic ventilation through continuous ridge vent
Continuous soffit vent
Tradtional cement stucco
Metal lath
Non-paper faced gypsum board with plaster finish and permeable (latex) paint
Sealant, adhesive or gasket at top plate
Caulking or sealant
2X6 24" o.c. advanced framing
Sealant at all penetrations
Building paper as bond break over Tyvek® StuccoWrap®
Fill rim joist with spray foam insulation for air sealing
Plywood sheathing
Non-paper faced gypsum board with plaster finish and permeable (latex) paint
Soil gas ventilation stack
Formaldehyde-free unfaced fiberglass batt insulation
Weep screed tucked under Tyvek® StuccoWrap® drainage plane
Metal flashing as termite shield epoxy sealed to slab; joints in flashing epoxy sealed or soldered for contiunity
Parge coat dampproofed with latex paint to reduce water absorption
Non-paper faced gypsum board with traditional stucco finish and permeable (latex) paint; held up from slab
Sealant, adhesive or gasket
Seal around anchor bolt penetration
Sealant, adhesive or gasket at bottom plate
Sill gasket
Concrete slab
Tensioning cable
Sealant at all slab penetrations
For termite protection provide 3'-0" of mulch and then drought-resistant plants
Ground slopes away from wall at 5% (6 in. per 10 ft.)
Sub-slab stone layer (no fines)
Perforated drain pipe added to "T" in order to couple sub-slab pressure field to vent stack
Concrete grade beam
Polyethylene vapor barrier extended under grade beam where it also acts as a capillary break



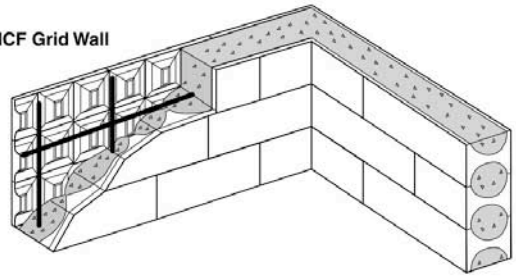
ICF Basement — ICF Above Grade Wall

- Foundation wall warm, can dry to the interior; extremely low likelihood of mold
- Basement floor slab can dry to the interior
- Protective membrane can be adhesive-backed roll roofing or other UV resistant material. Below grade sheet waterproofing or ice-dam protection membranes can also be used if protected from UV exposure by using aluminum sheet stock or other alternative materials.

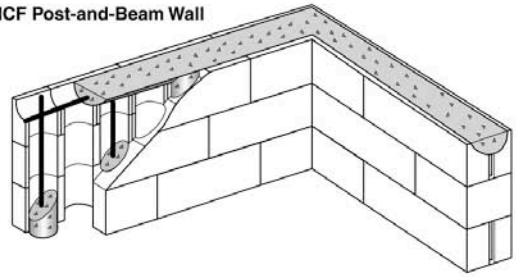
Typical ICF Flat Wall



Typical ICF Grid Wall

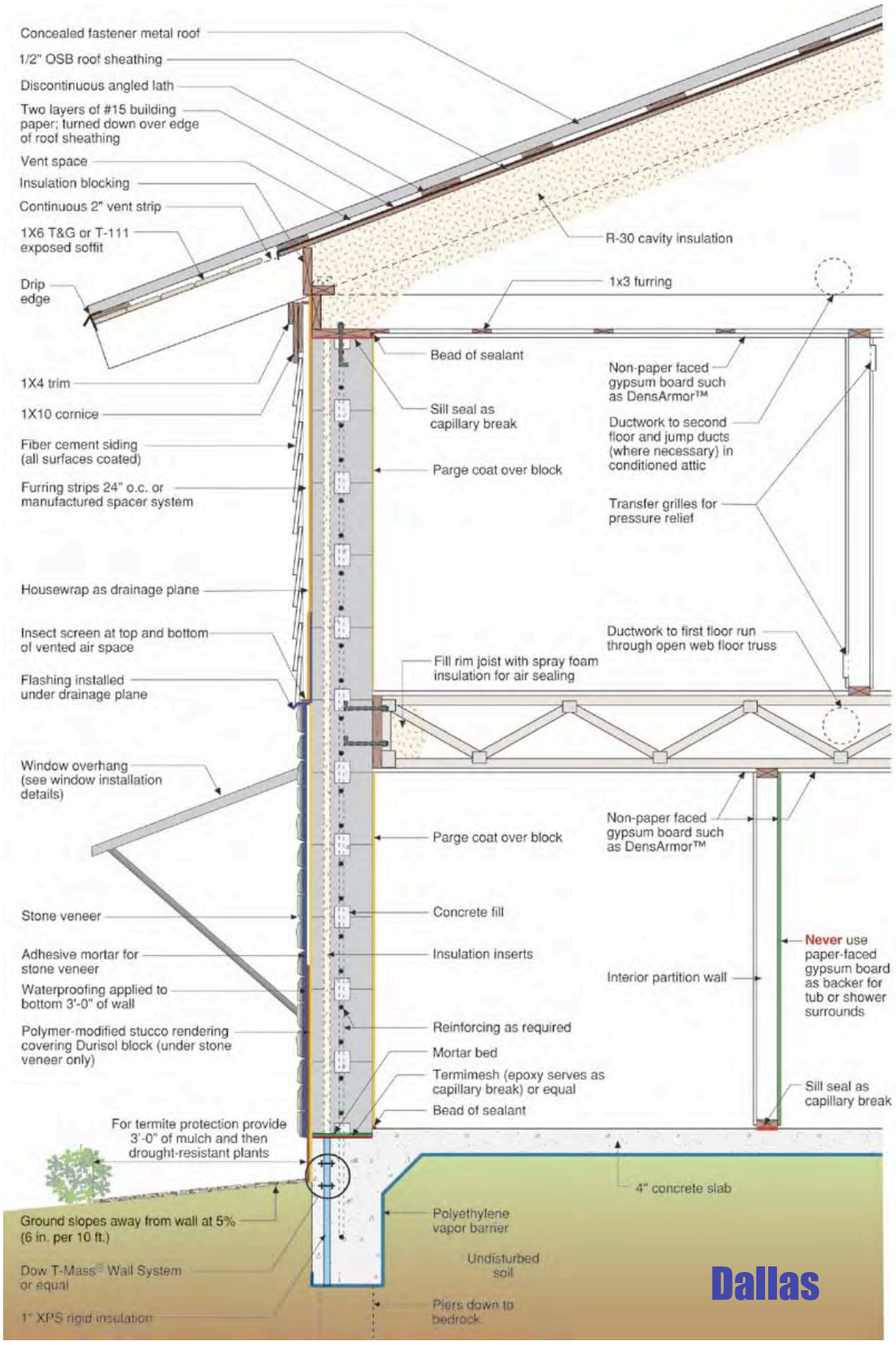


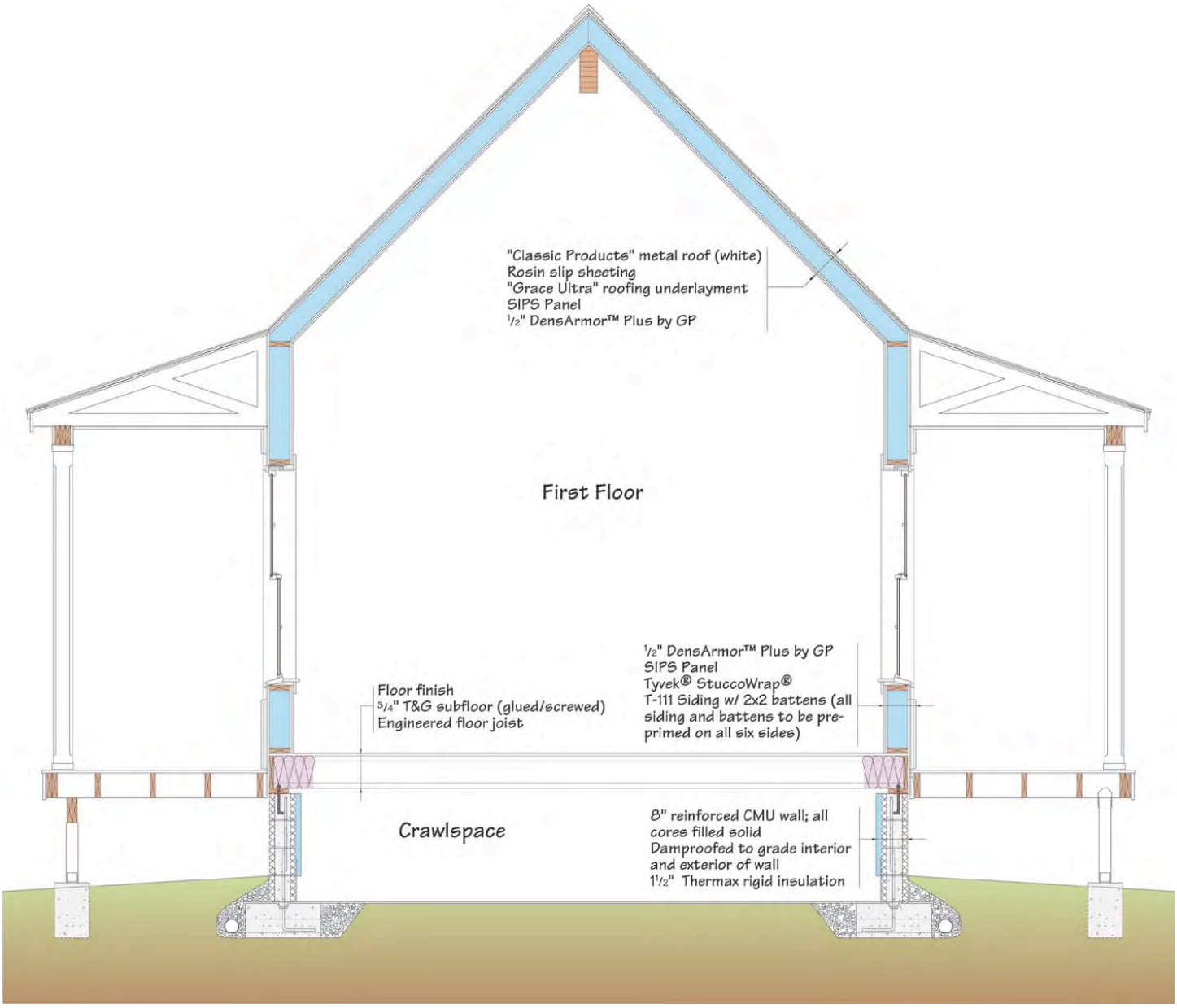
Typical ICF Post-and-Beam Wall



Types of ICF Walls

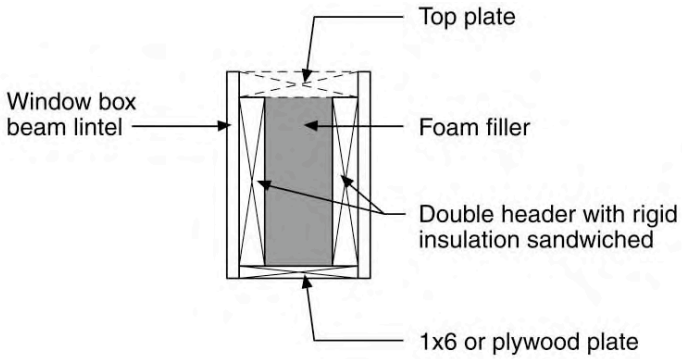
- ICF's are forms for cast concrete walls that stay in place as a part of the wall after the concrete is poured
- Flat systems are filled with concrete like conventionally cast walls
- Grid systems have a waffle pattern where the concrete varies in thickness
- Post and beam systems have discrete columns of horizontal and vertical concrete completely surrounded by foam

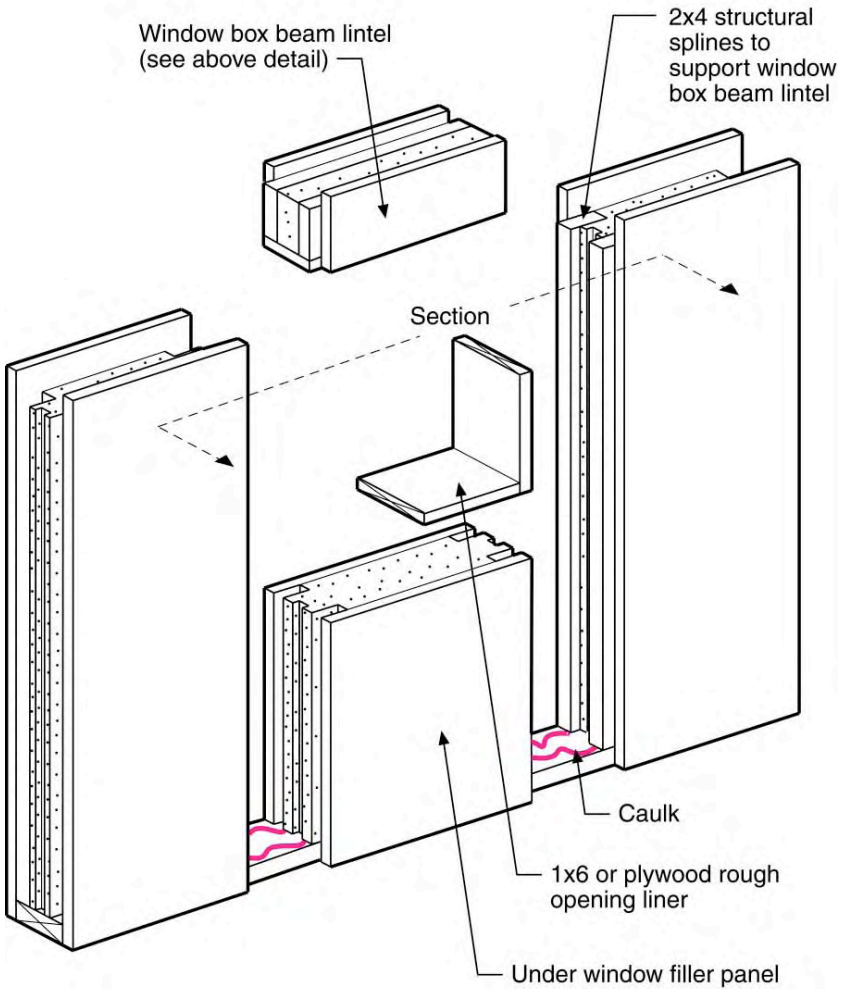

Concealed fastener metal roof
1/2" OSB roof sheathing
Discontinuous angled lath
Two layers of #15 building paper; turned down over edge of roof sheathing
Vent space
Insulation blocking
Continuous 2" vent strip
1X6 T&G or T-111 exposed soffit
Drip edge
1X4 trim
1X10 cornice
Fiber cement siding (all surfaces coated)
Furring strips 24" o.c. or manufactured spacer system
Housewrap as drainage plane
Insect screen at top and bottom of vented air space
Flashing installed under drainage plane
Window overhang (see window installation details)
Stone veneer
Adhesive mortar for stone veneer
Waterproofing applied to bottom 3'-0" of wall
Polymer-modified stucco rendering covering Durisol block (under stone veneer only)
For termite protection provide 3'-0" of mulch and then drought-resistant plants
Ground slopes away from wall at 5% (6 in. per 10 ft.)
Dow T-Mass® Wall System or equal
1" XPS rigid insulation
R-30 cavity insulation
1x3 furring
Bead of sealant
Sill seal as capillary break
Parge coat over block
Fill rim joist with spray foam insulation for air sealing
Parge coat over block
Concrete fill
Insulation inserts
Reinforcing as required
Mortar bed
Termimesh (epoxy serves as capillary break) or equal
Bead of sealant
Polyethylene vapor barrier
Undisturbed soil
Piers down to bedrock
Non-paper faced gypsum board such as DensArmor™
Ductwork to second floor and jump ducts (where necessary) in conditioned attic
Transfer grilles for pressure relief
Ductwork to first floor run through open web floor truss
Non-paper faced gypsum board such as DensArmor™
Interior partition wall
Never use paper-faced gypsum board as backer for tub or shower surrounds
Sill seal as capillary break
4" concrete slab
Dallas



Okefenokee, GA

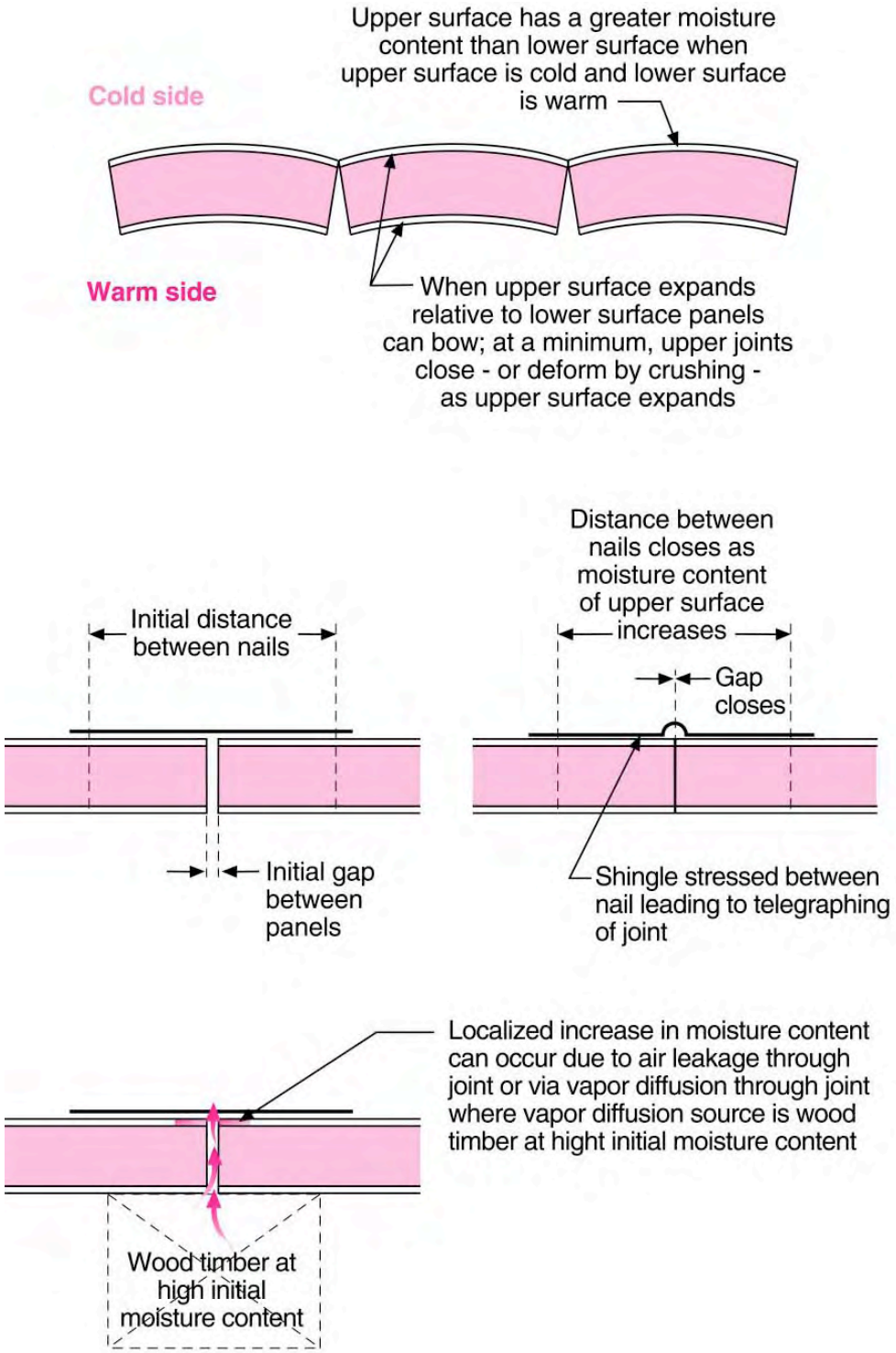
April 8, 2005





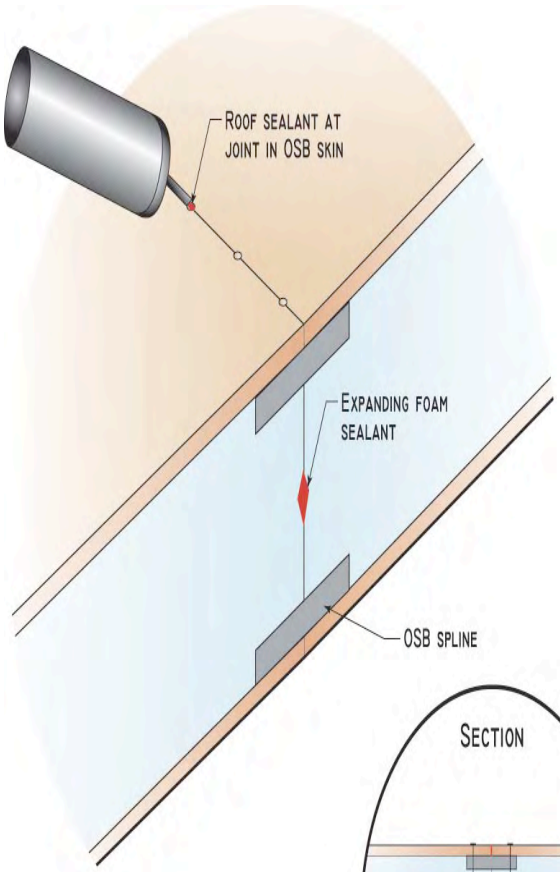
SIPS Load Bearing Window Sliding Door Opening

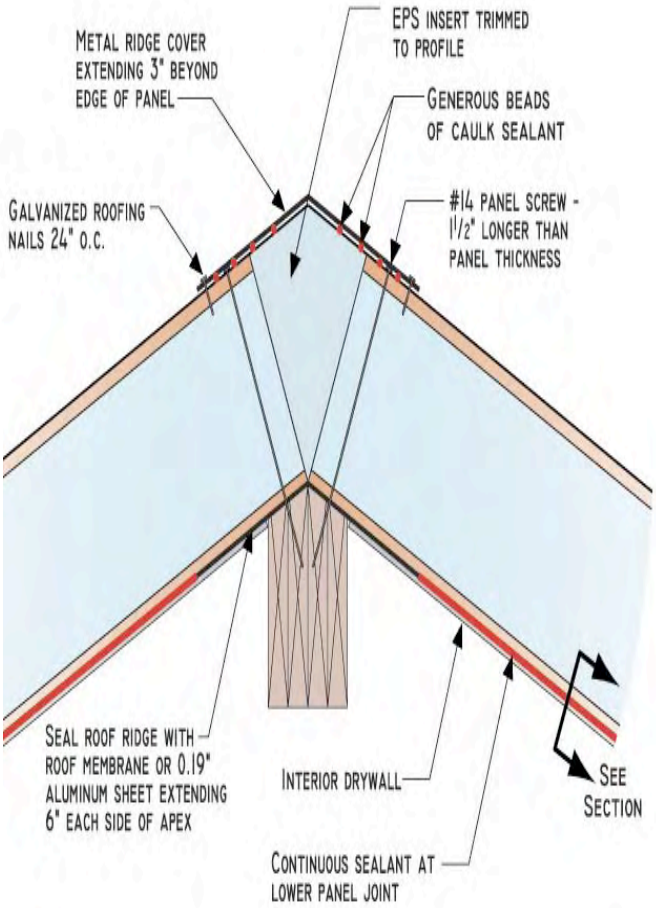
April 8, 2005

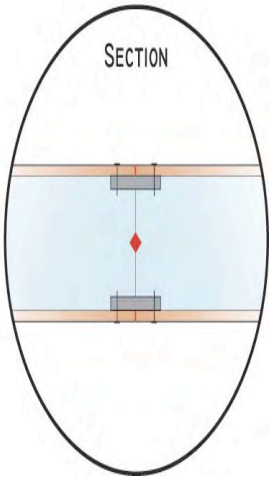


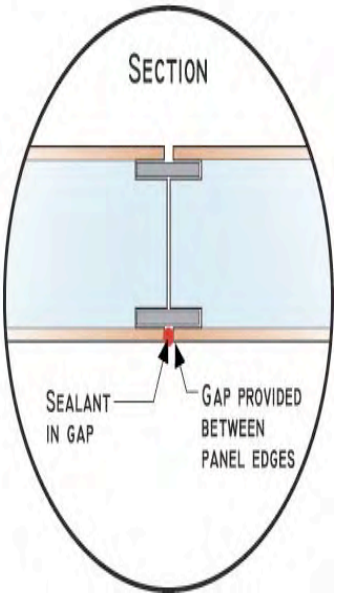
Telegraphing of Panel Joints

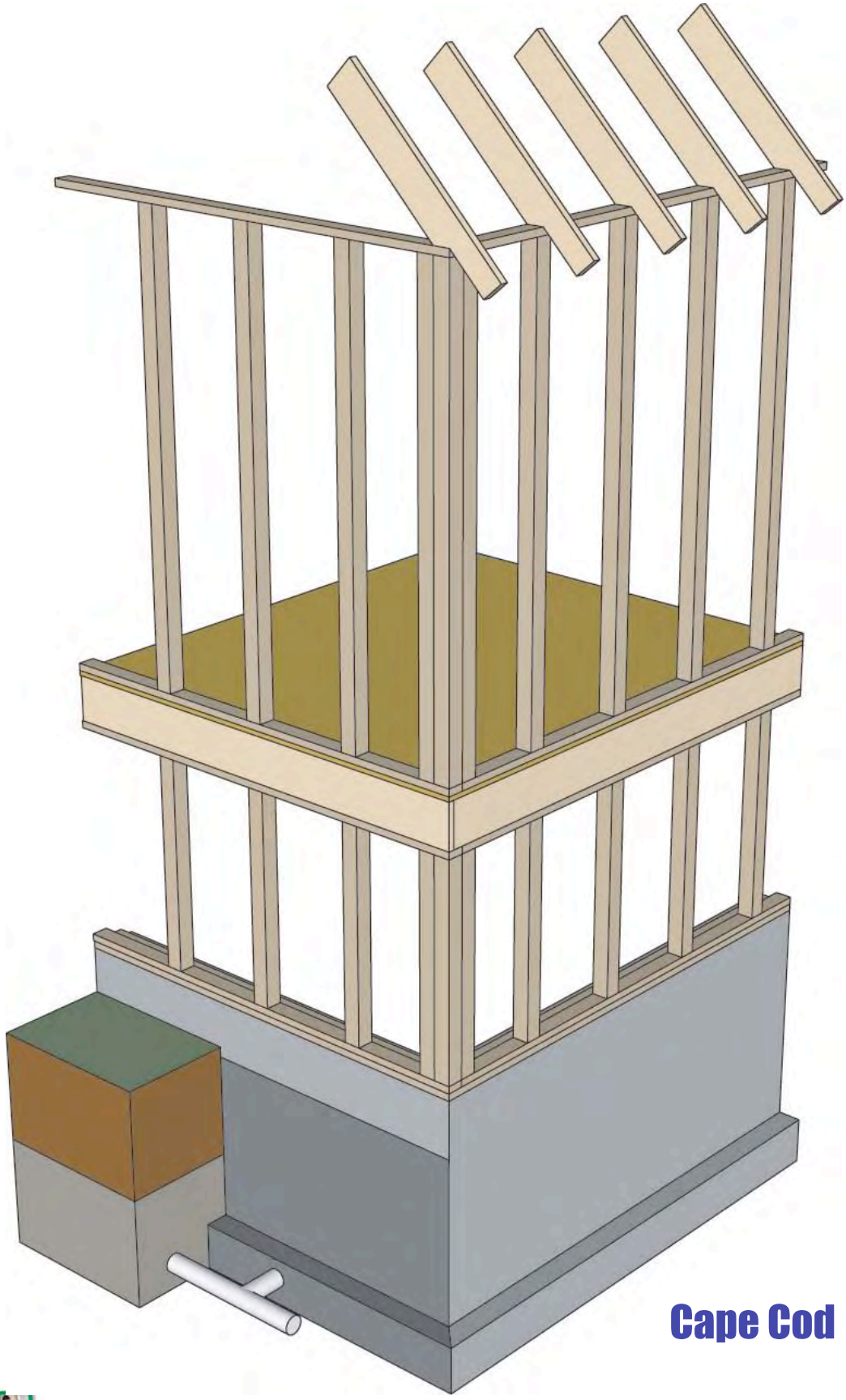
April 8, 2005


ROOF SEALANT AT JOINT IN OSB SKIN
EXPANDING FOAM SEALANT
OSB SPLINE


METAL RIDGE COVER EXTENDING 3" BEYOND EDGE OF PANEL
EPS INSERT TRIMMED TO PROFILE
GENEROUS BEADS OF CAULK SEALANT
GALVANIZED ROOFING NAILS 24" O.C.
#14 PANEL SCREW - 1 1/2" LONGER THAN PANEL THICKNESS
SEAL ROOF RIDGE WITH ROOF MEMBRANE OR 0.19" ALUMINUM SHEET EXTENDING 6" EACH SIDE OF APEX
INTERIOR DRYWALL
SEE SECTION
CONTINUOUS SEALANT AT LOWER PANEL JOINT

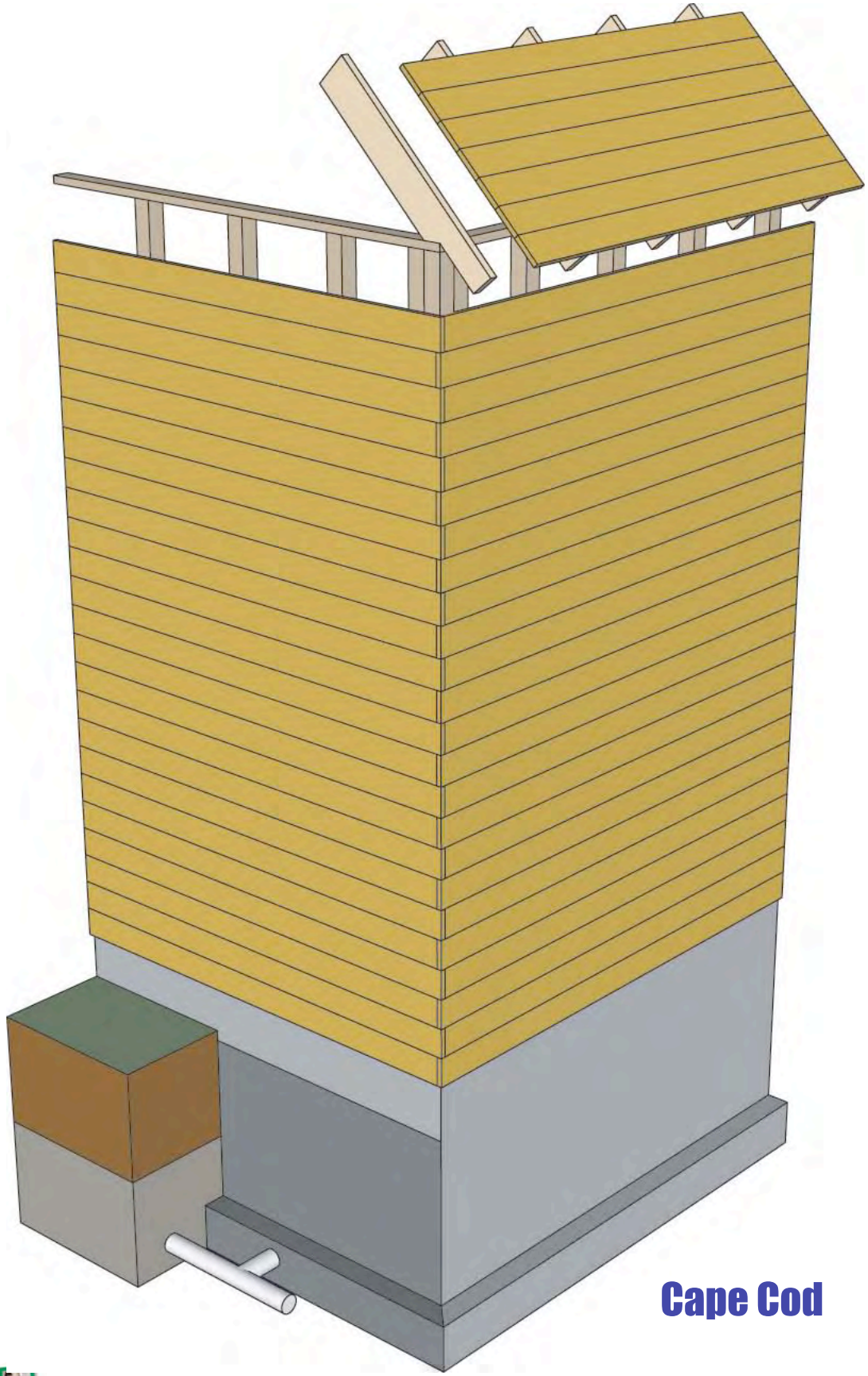

SECTION


SECTION
SEALANT IN GAP
GAP PROVIDED BETWEEN PANEL EDGES



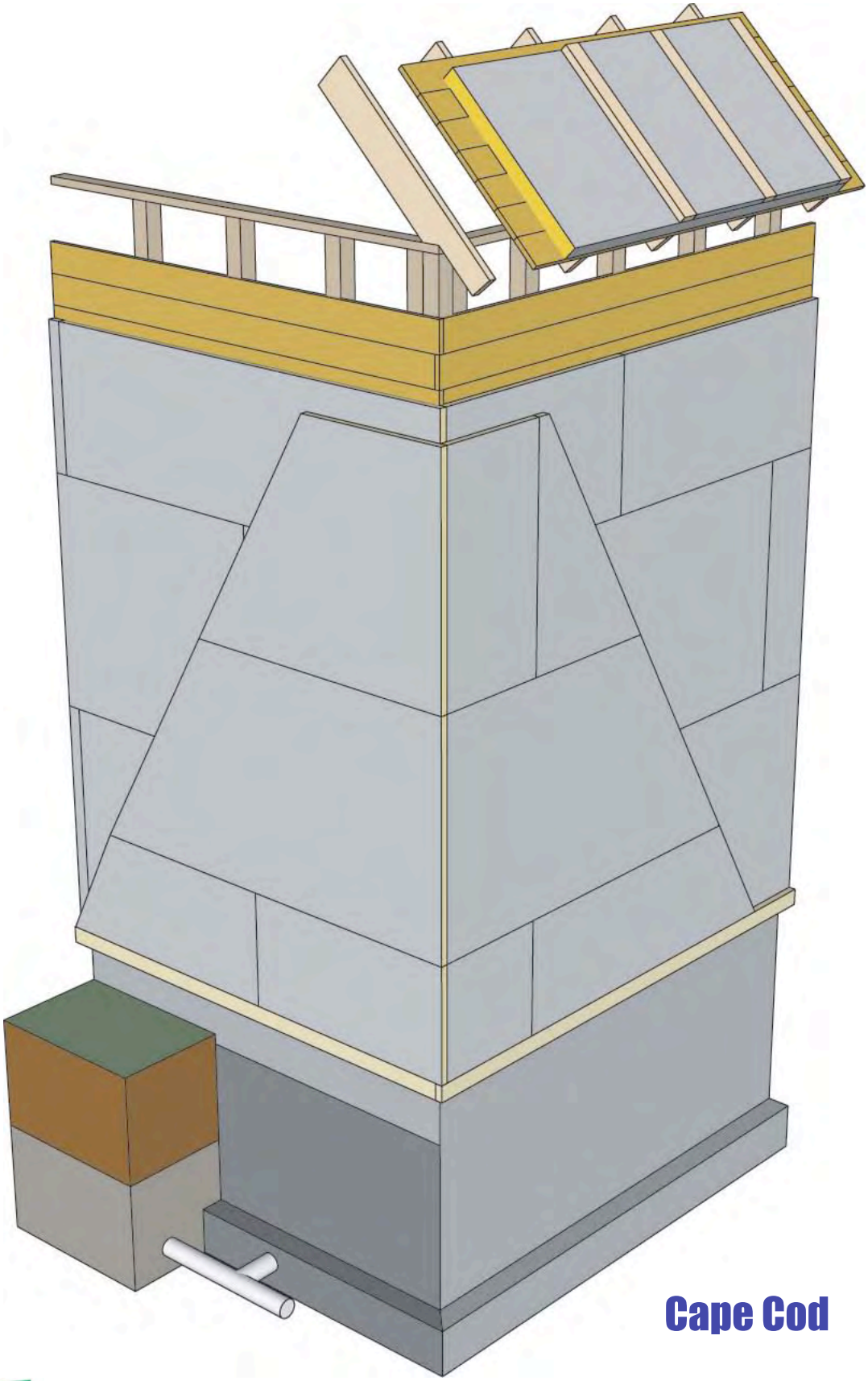
Cape Cod

April 8, 2005



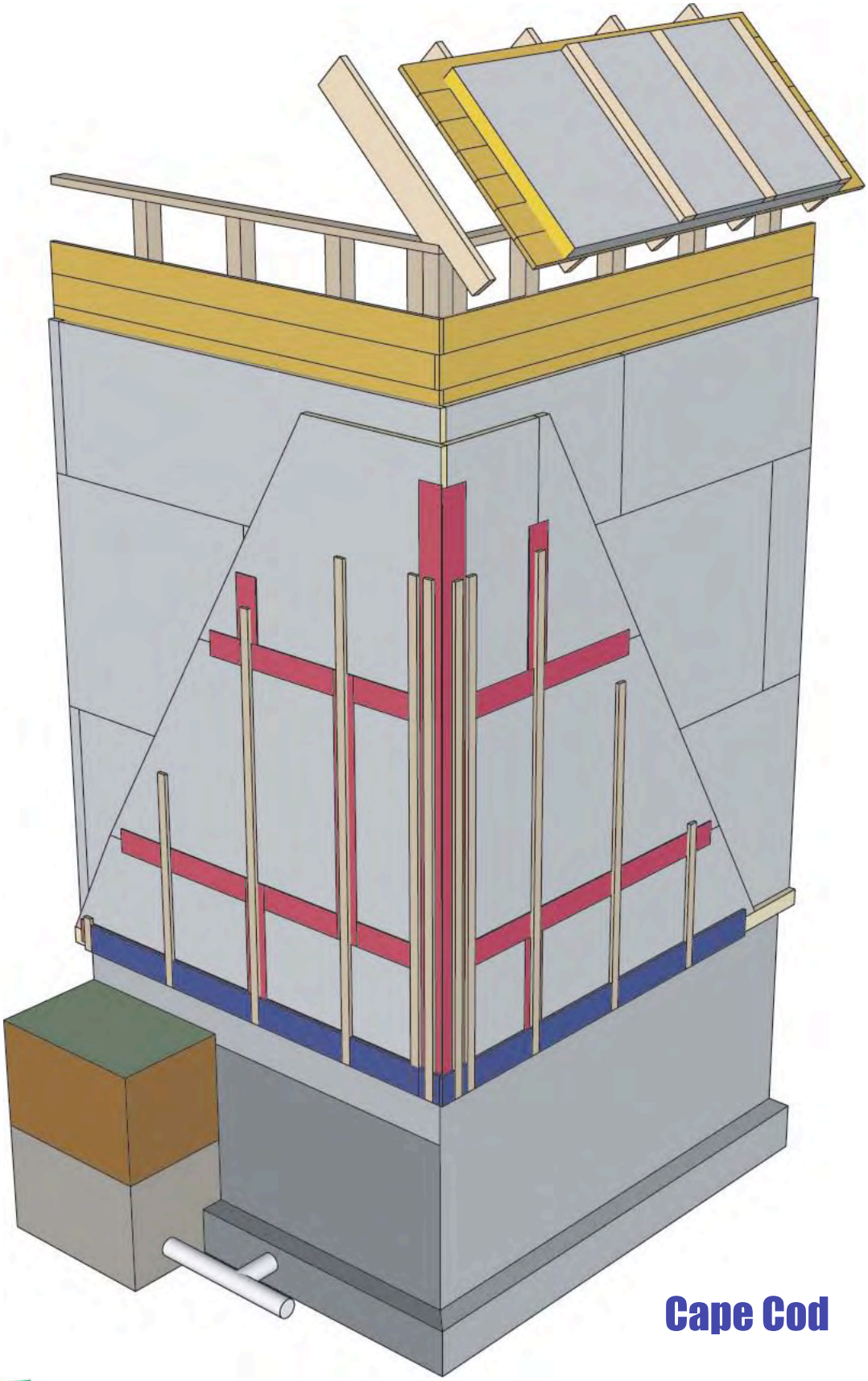
Cape Cod

April 8, 2005



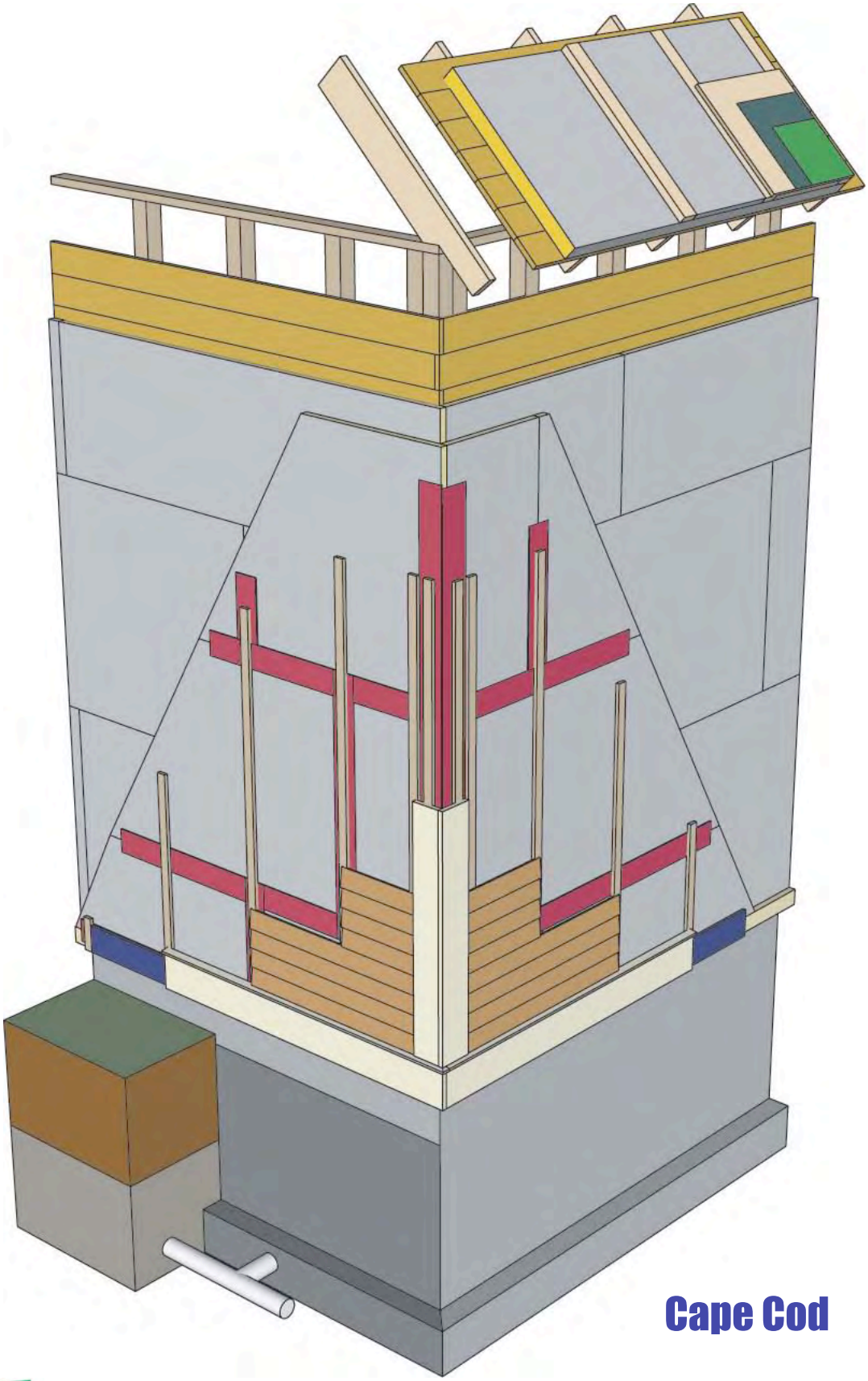
Cape Cod

April 8, 2005



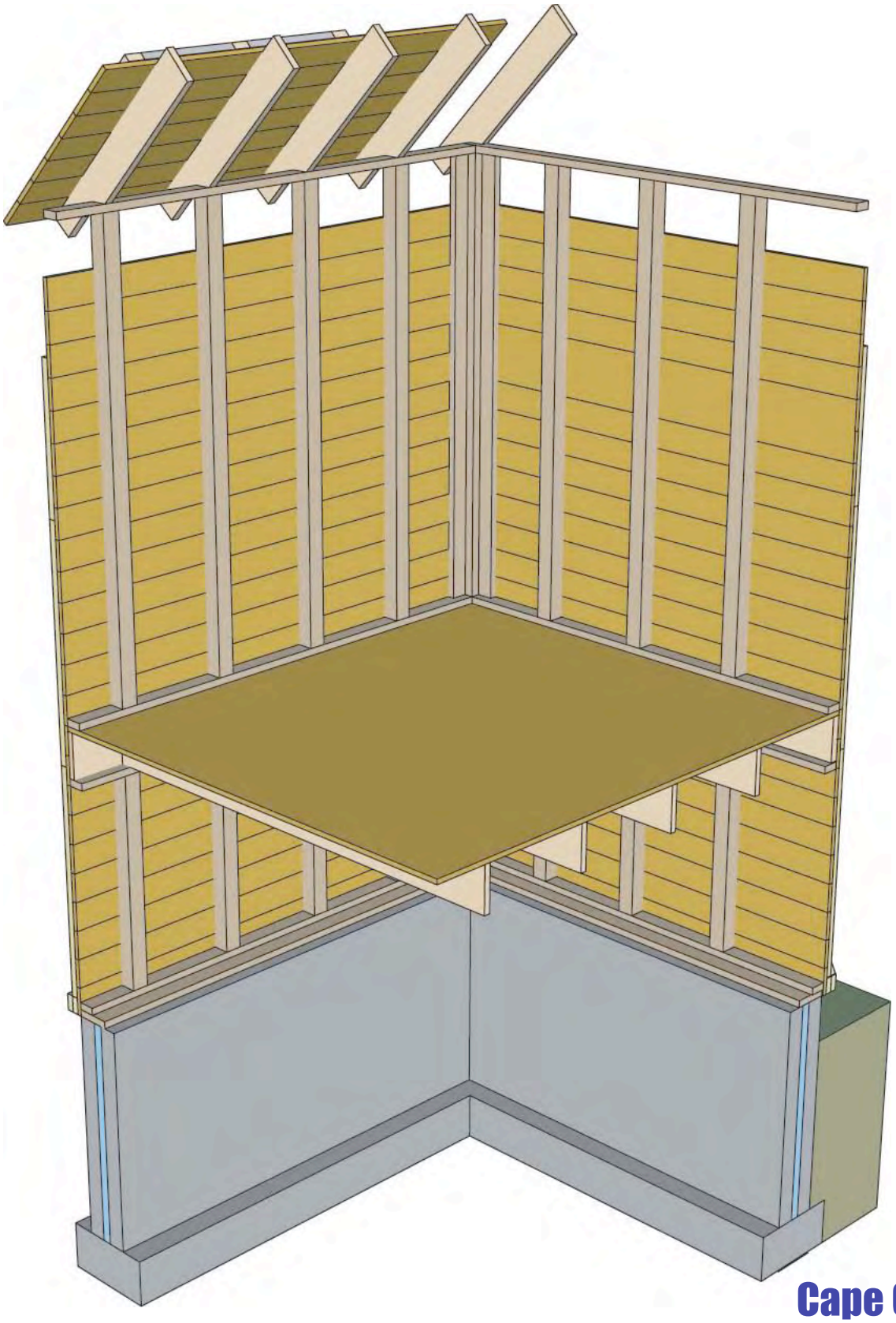
Cape Cod

April 8, 2005



Cape Cod

April 8, 2005



Cape Cod

April 8, 2005

Building America SM
U.S. Department of Energy