Joseph Lstiburek, Ph.D., P.Eng, ASHRAE Fellow

Building Science

Adventures In Building Science

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Life is Tough Enough As it Is…

Life is Tough Enough As it Is…

It’s Harder When You Are Stupid

Don’t Do Stupid Things

R2

R2

R4

R2

R4

R6

R2

R4

R6

R8

R2

R4

R6

R8

R8

R2

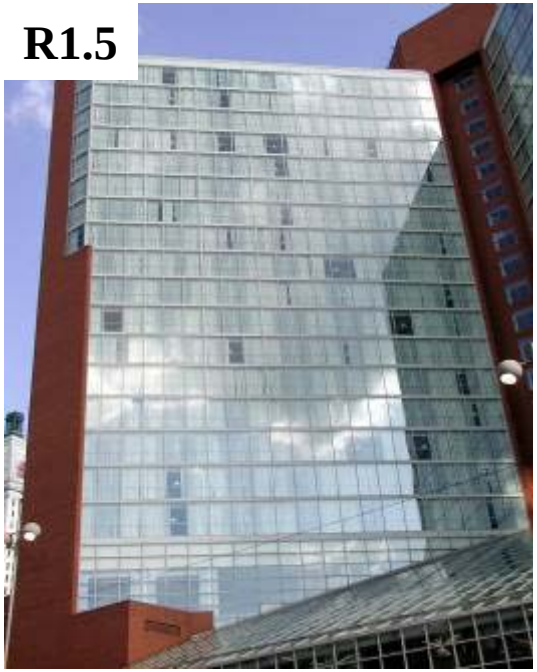
R4

R6

R8

R8

R1.5



R2

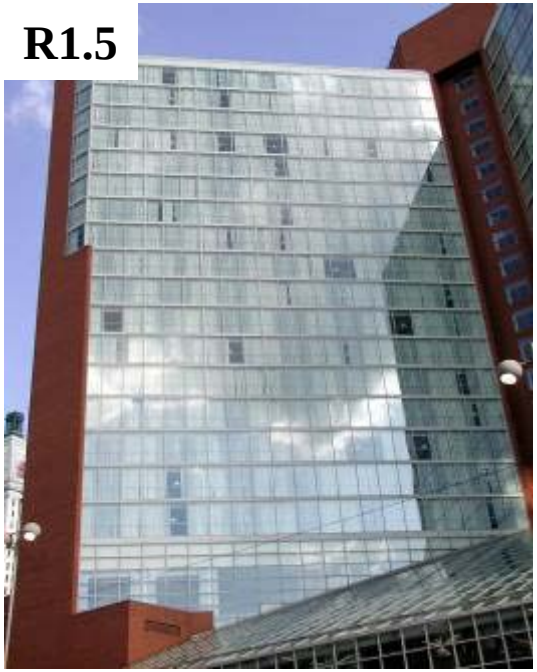
R4

R6

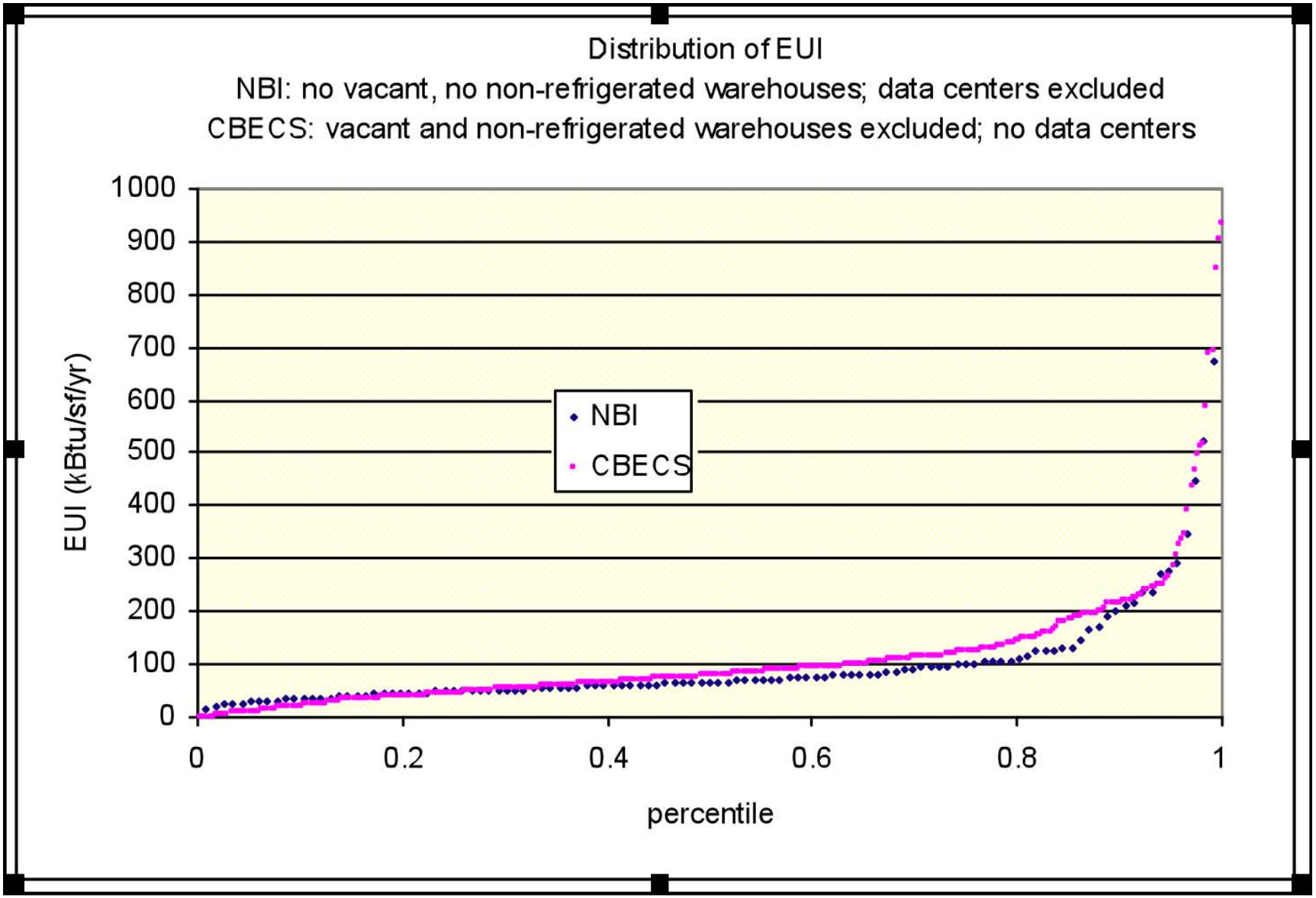
R8

R8

R1.5



R2


Distribution of EUI
NBI: no vacant, no non-refrigerated warehouses; data centers excluded
CBECS: vacant and non-refrigerated warehouses excluded; no data centers
EUI (kBtu/sf/yr)
1000
900
800
700
600
500
400
300
200
100
0
0
0.2
0.4
0.6
0.8
1
percentile
NBI
CBECS

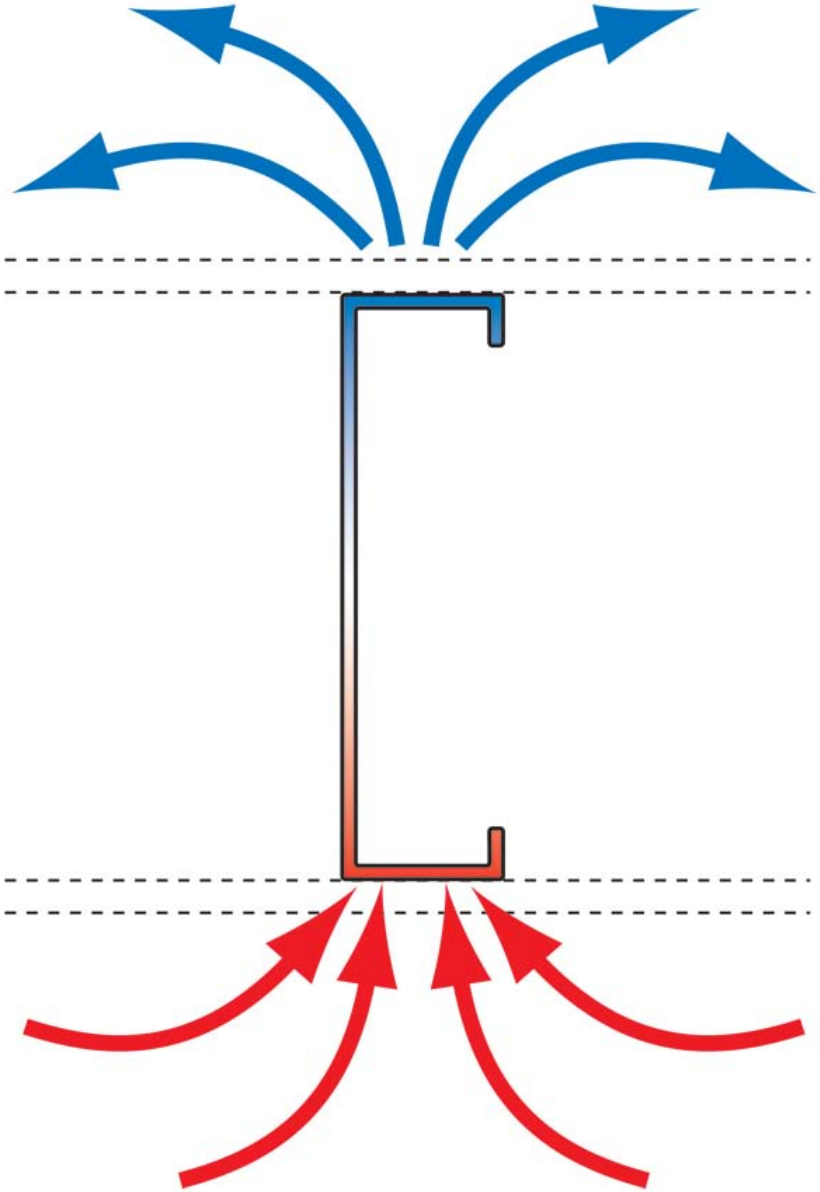
Too Much Glass

Too Leaky

Too Much Air - Way Over Ventilated

Too Many Thermal Bridges

Too Many Gimmicks



Heat Flow Is From Warm To Cold

Moisture Flow Is From Warm To Cold

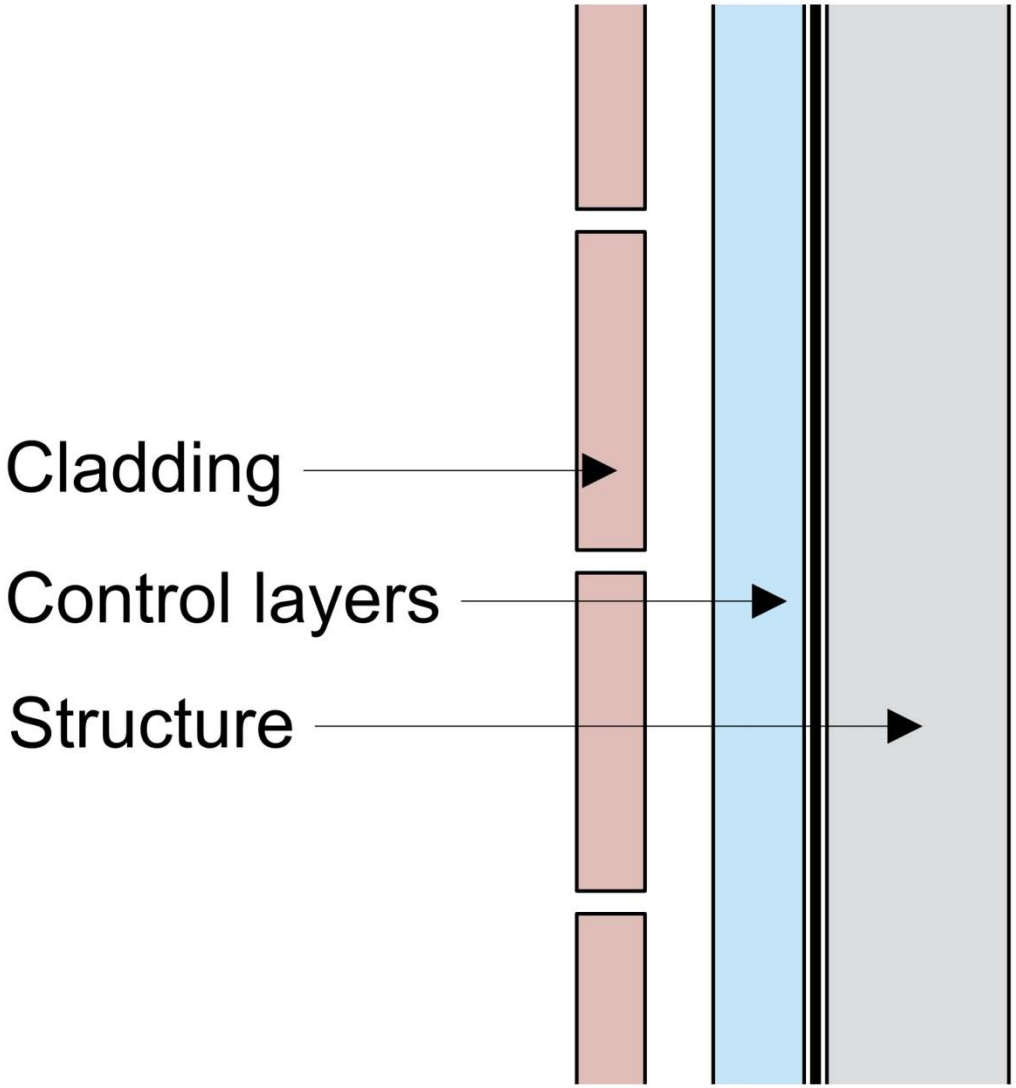
Moisture Flow Is From More To Less

Air Flow Is From A Higher Pressure to a Lower Pressure

Gravity Acts Down

GUARDIAN

Prowler
CUTTING
SHEETROCK INST.

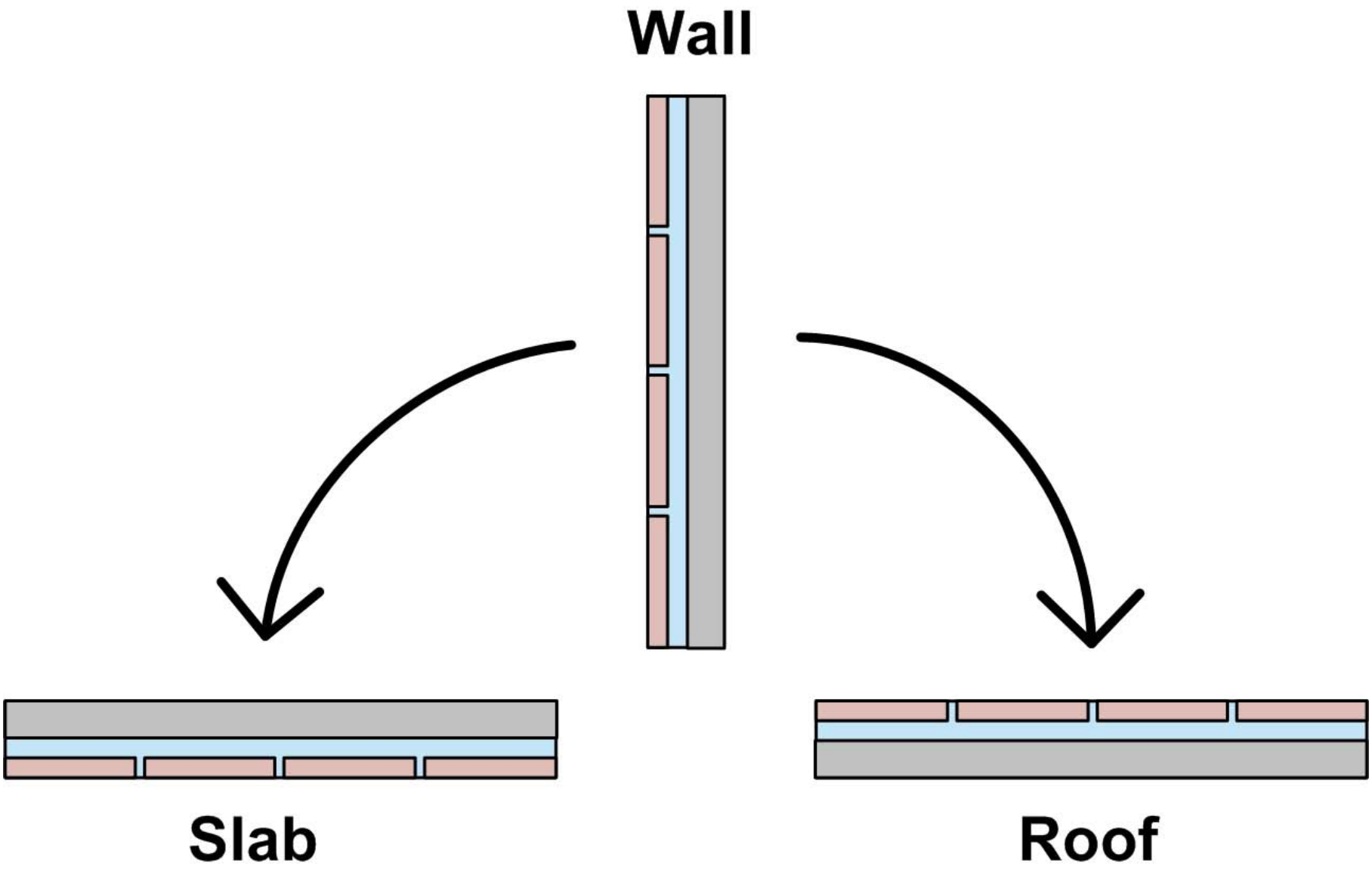

Cladding
Control layers
Structure

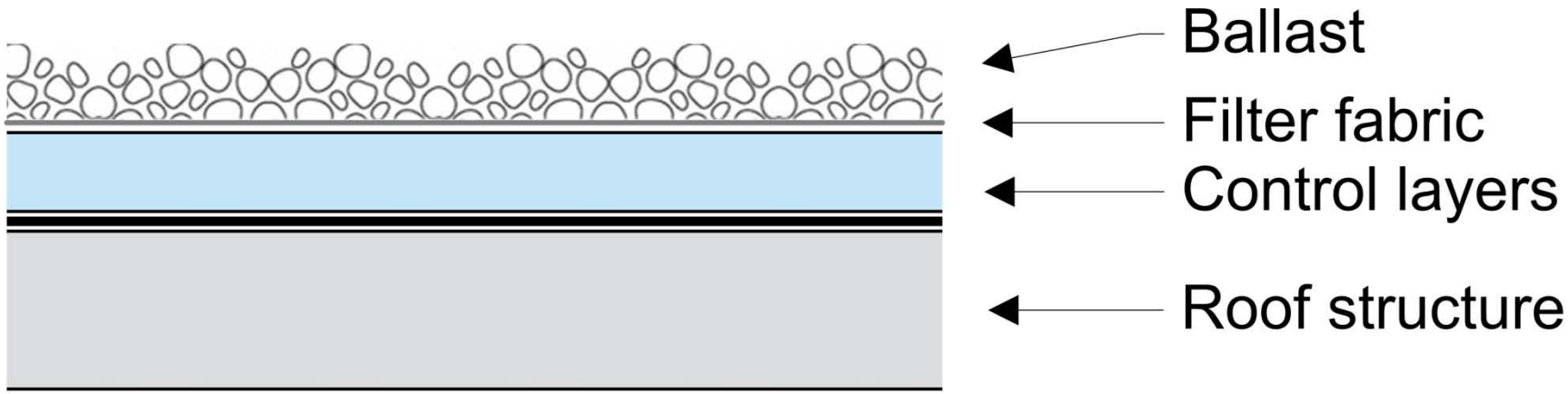
Rain Control Layer

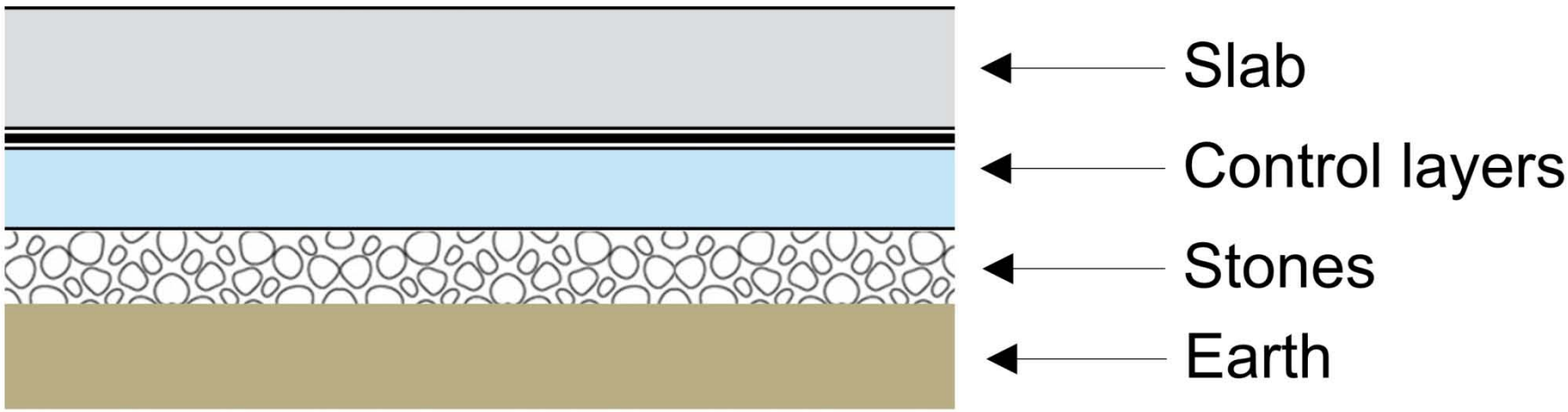
Air Control Layer

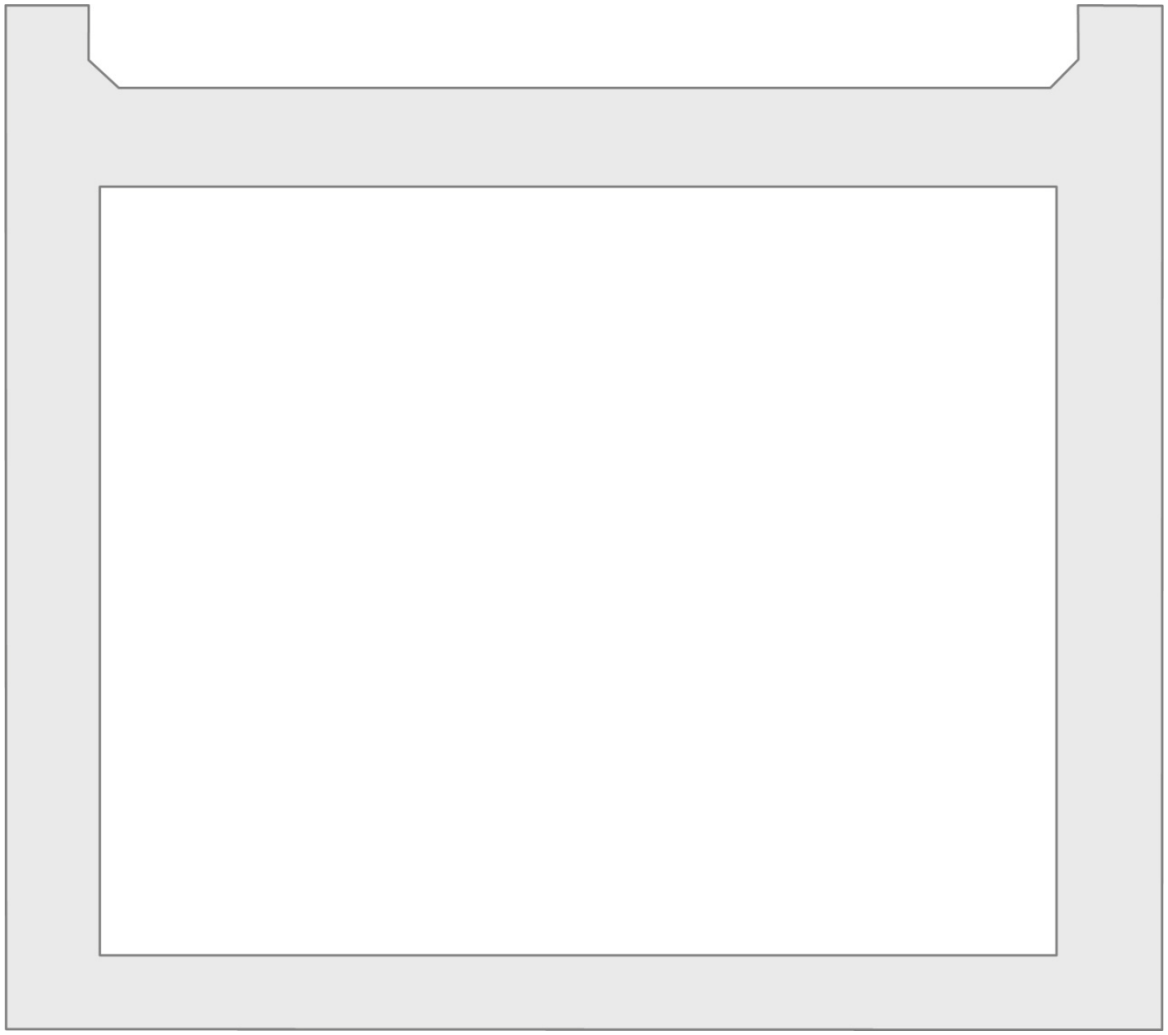
Vapor Control Layer

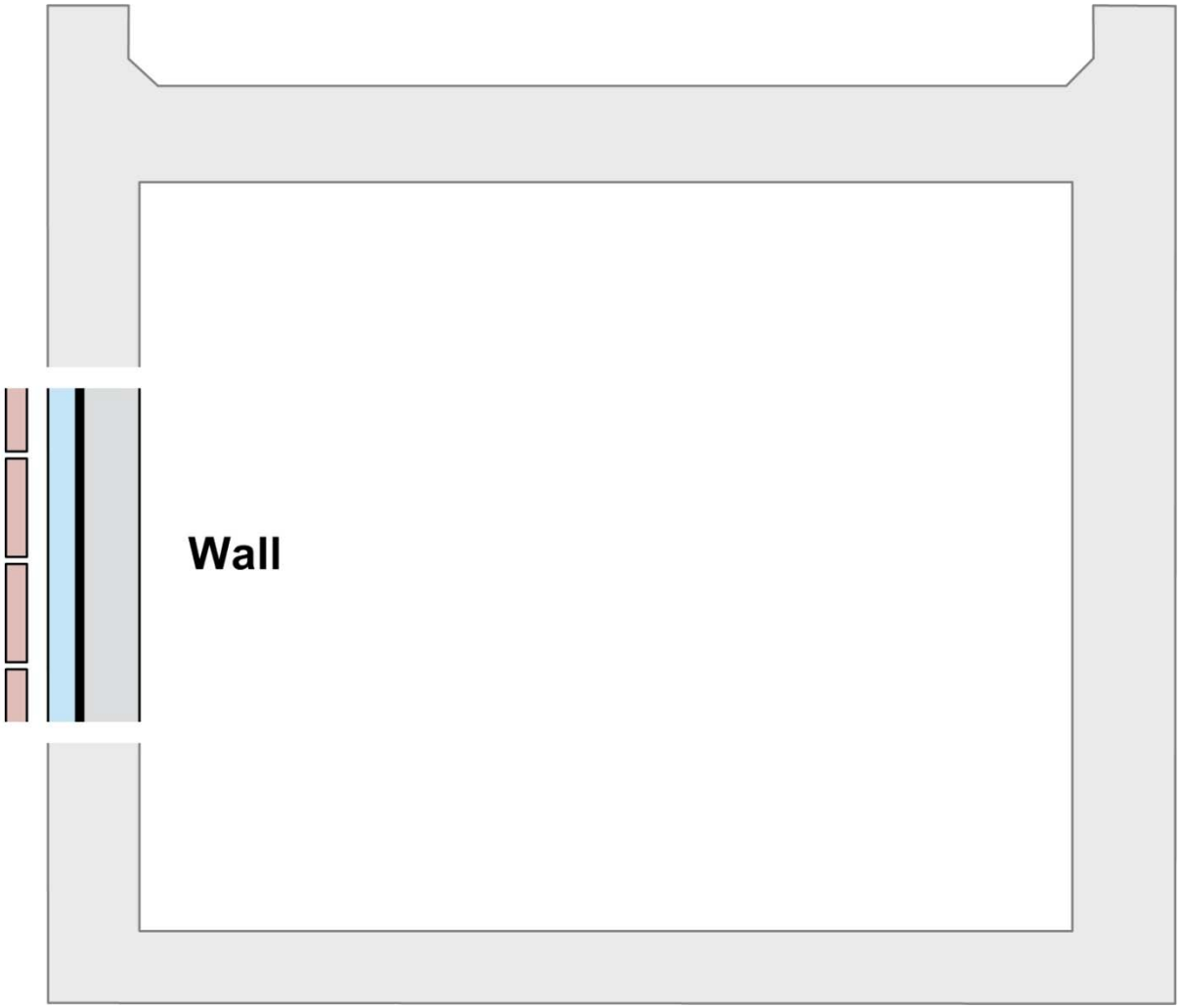
Thermal Control Layer

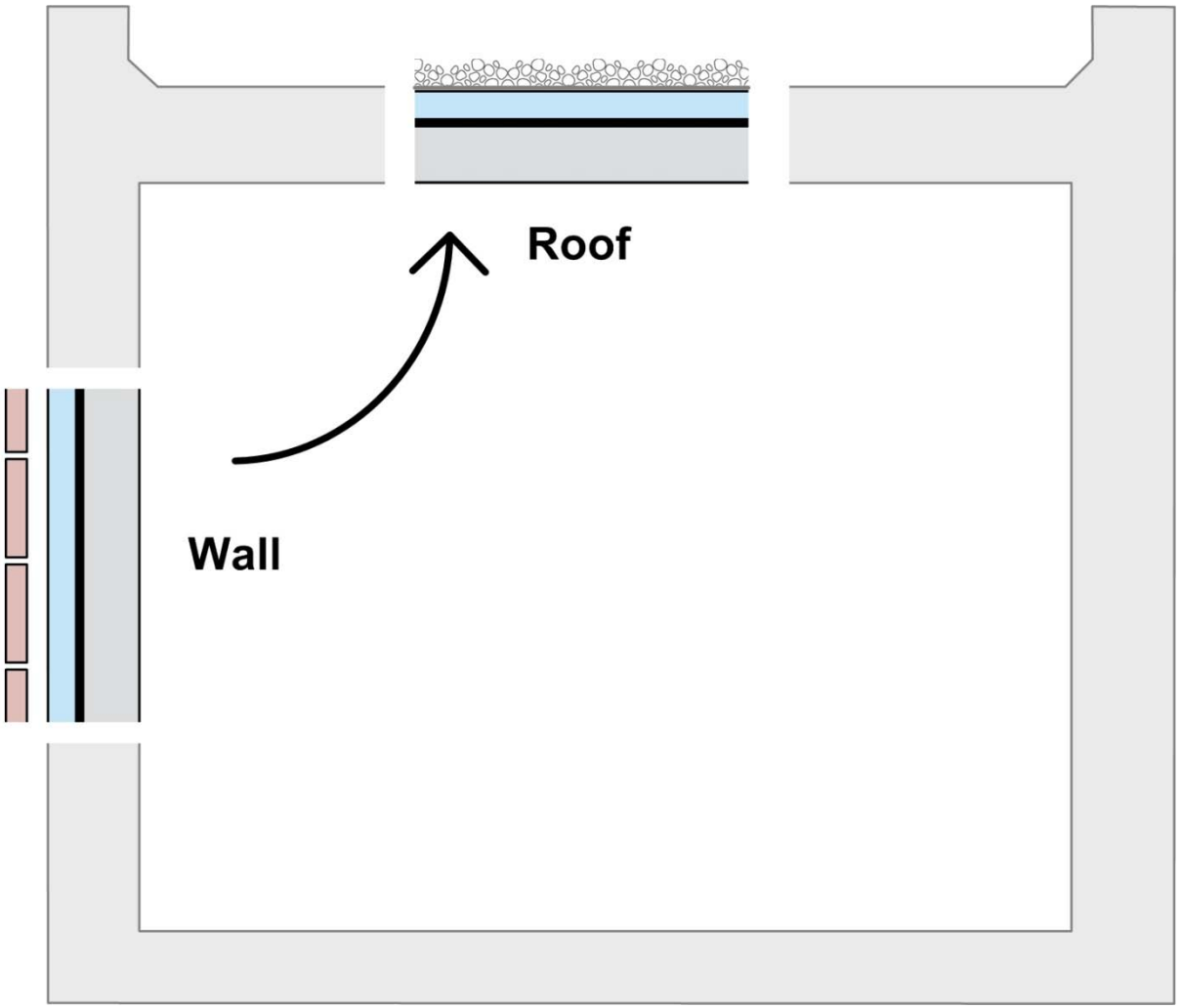

Wall
Slab
Roof

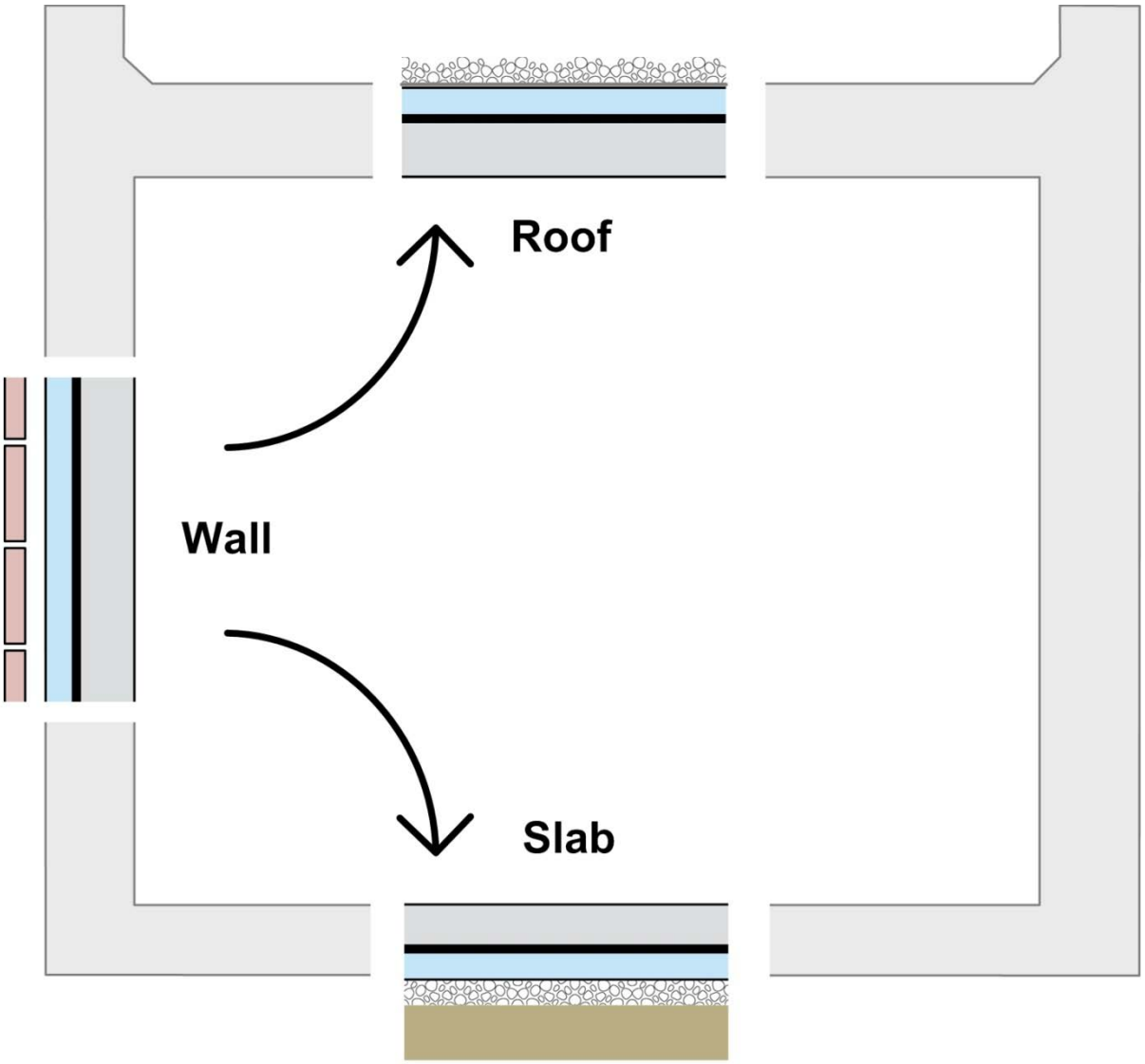

Ballast
Filter fabric
Control layers
Roof structure

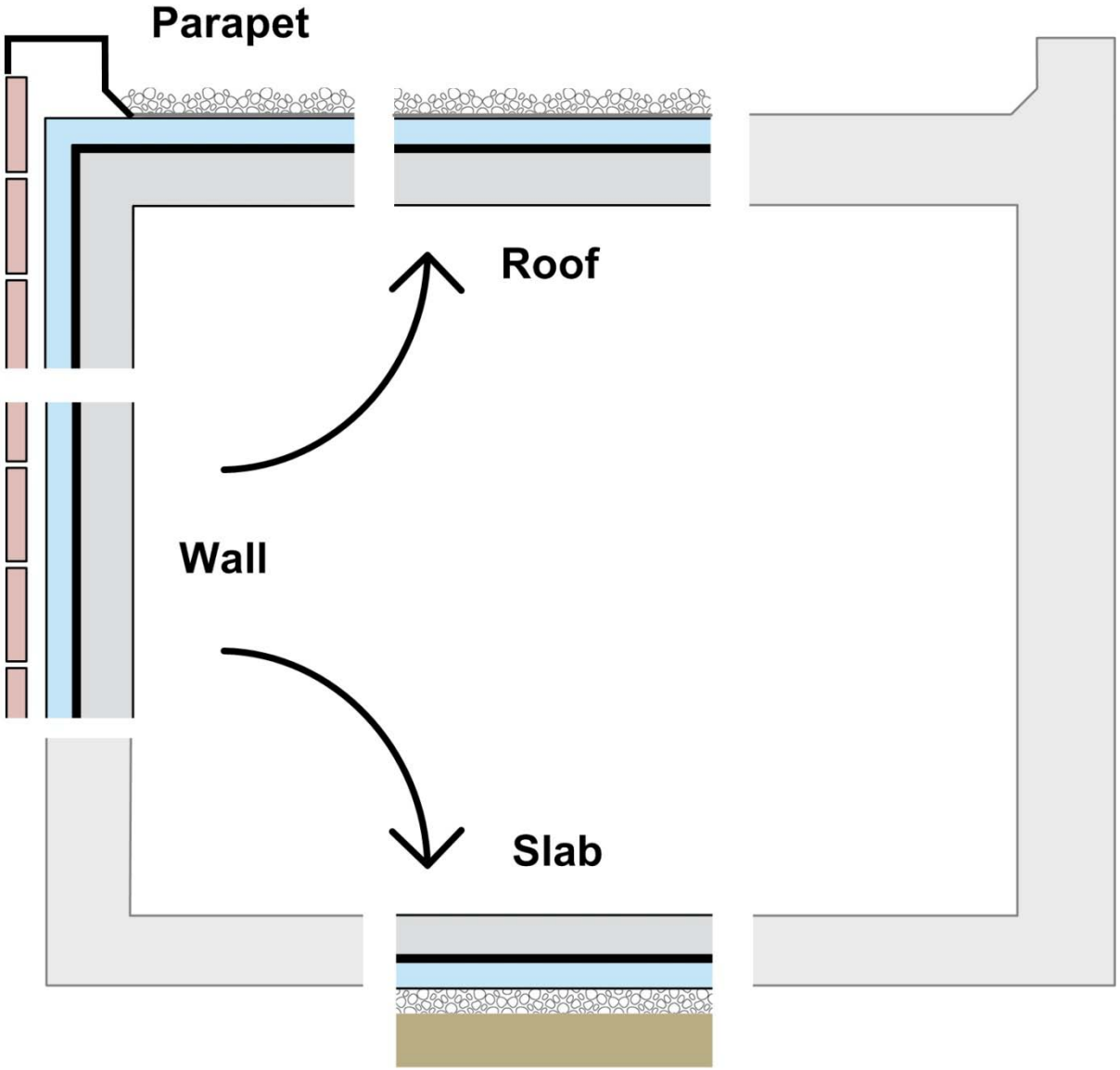

Slab
Control layers
Stones
Earth

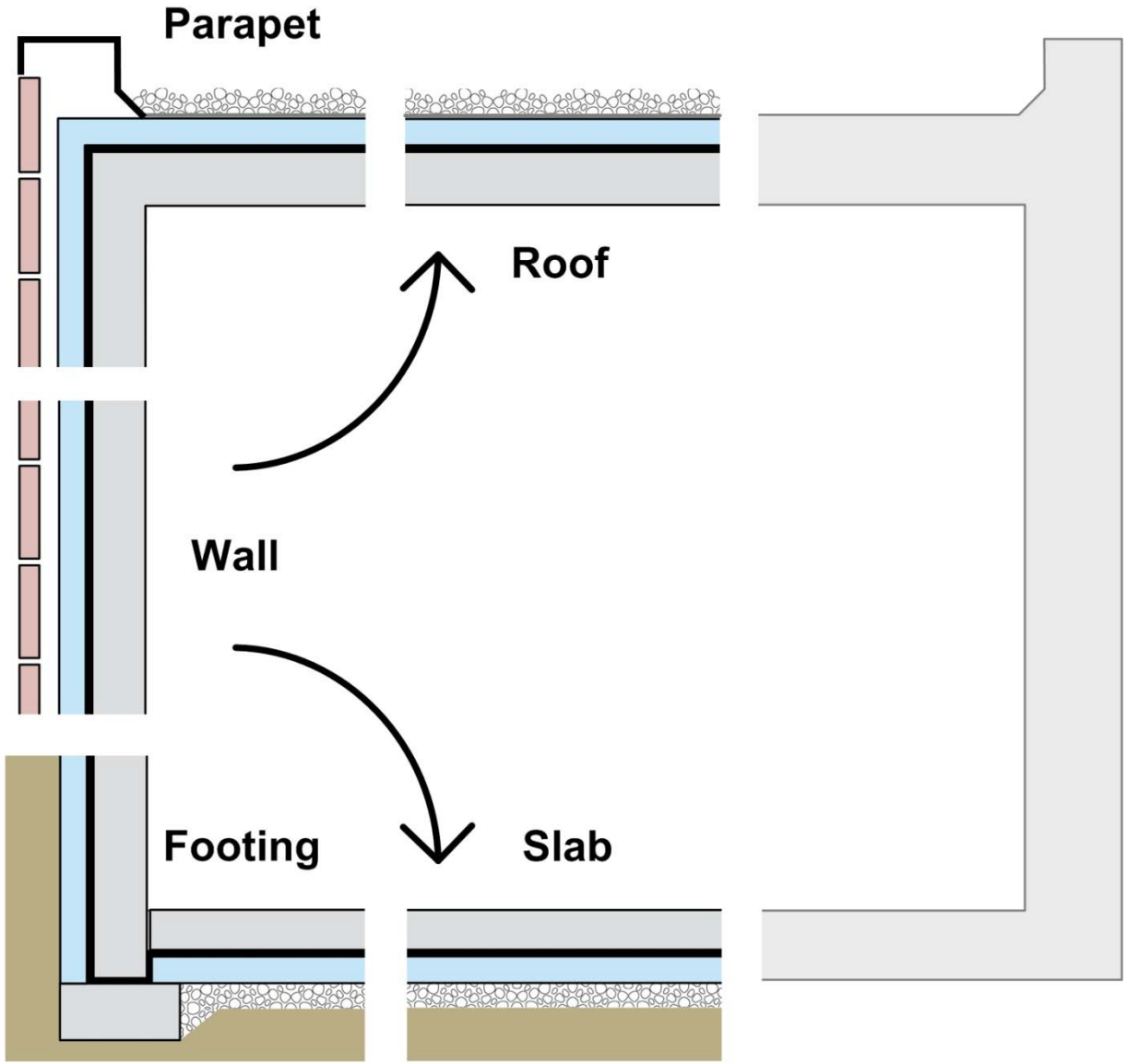


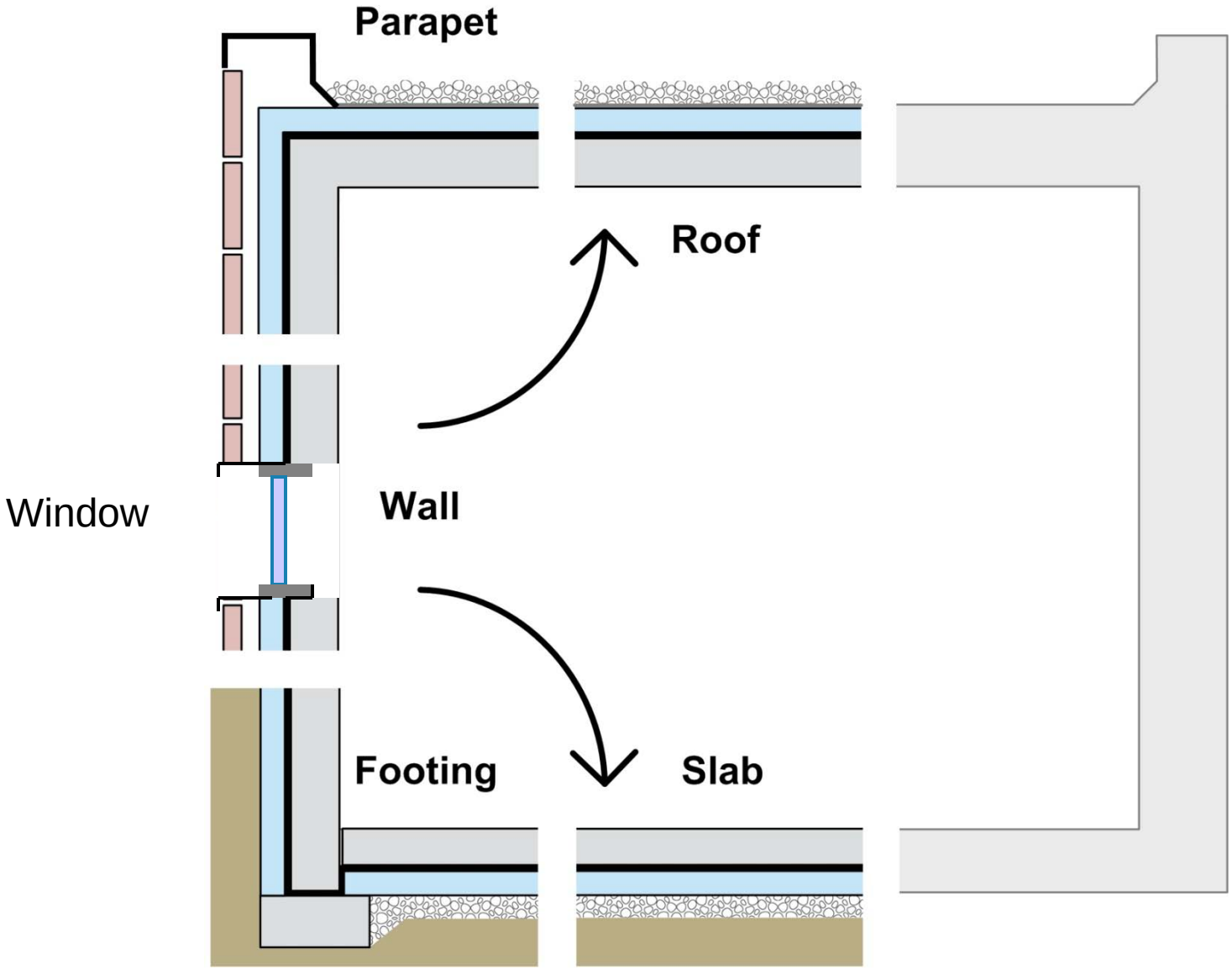

Wall


Roof
Wall

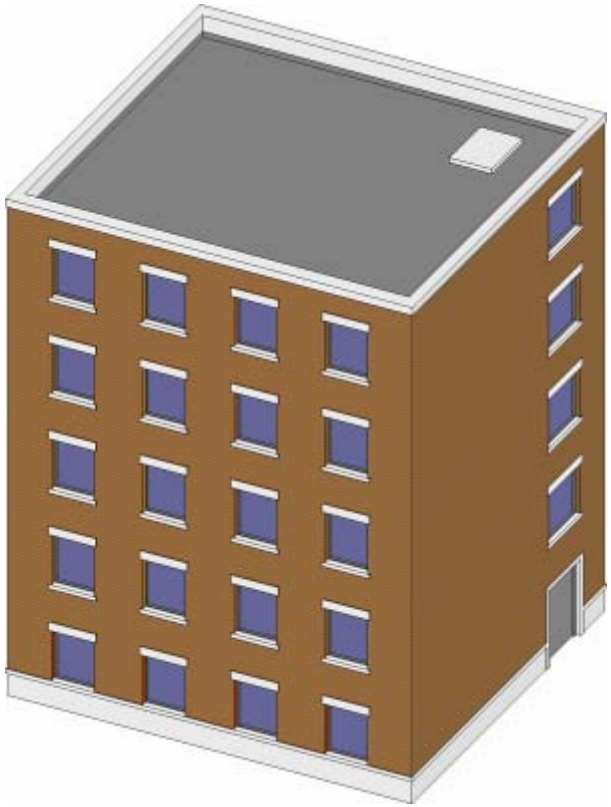

Roof
Wall
Slab


Parapet
Roof
Wall
Slab


Parapet
Roof
Wall
Footing
Slab


Parapet
Roof
Window
Wall
Footing
Slab

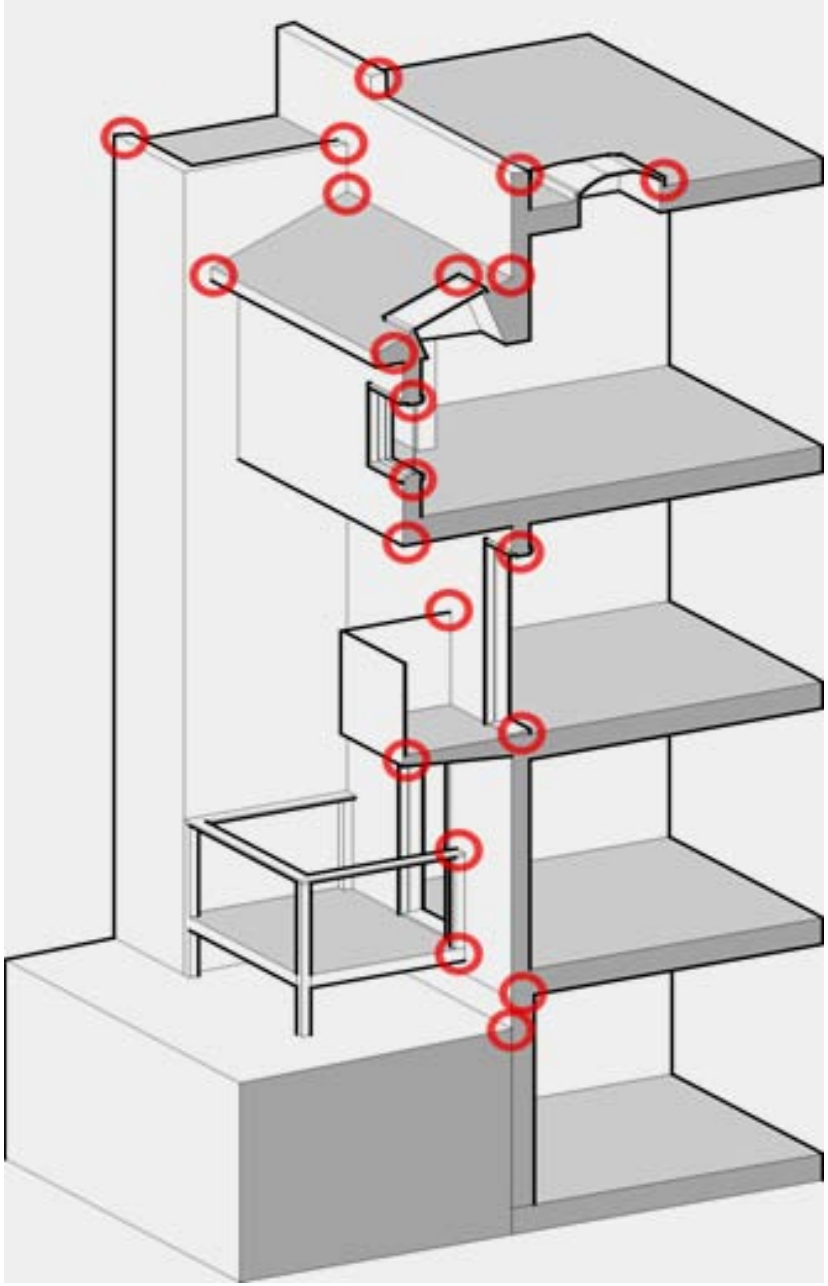
Commercial Enclosure: Simple Layers

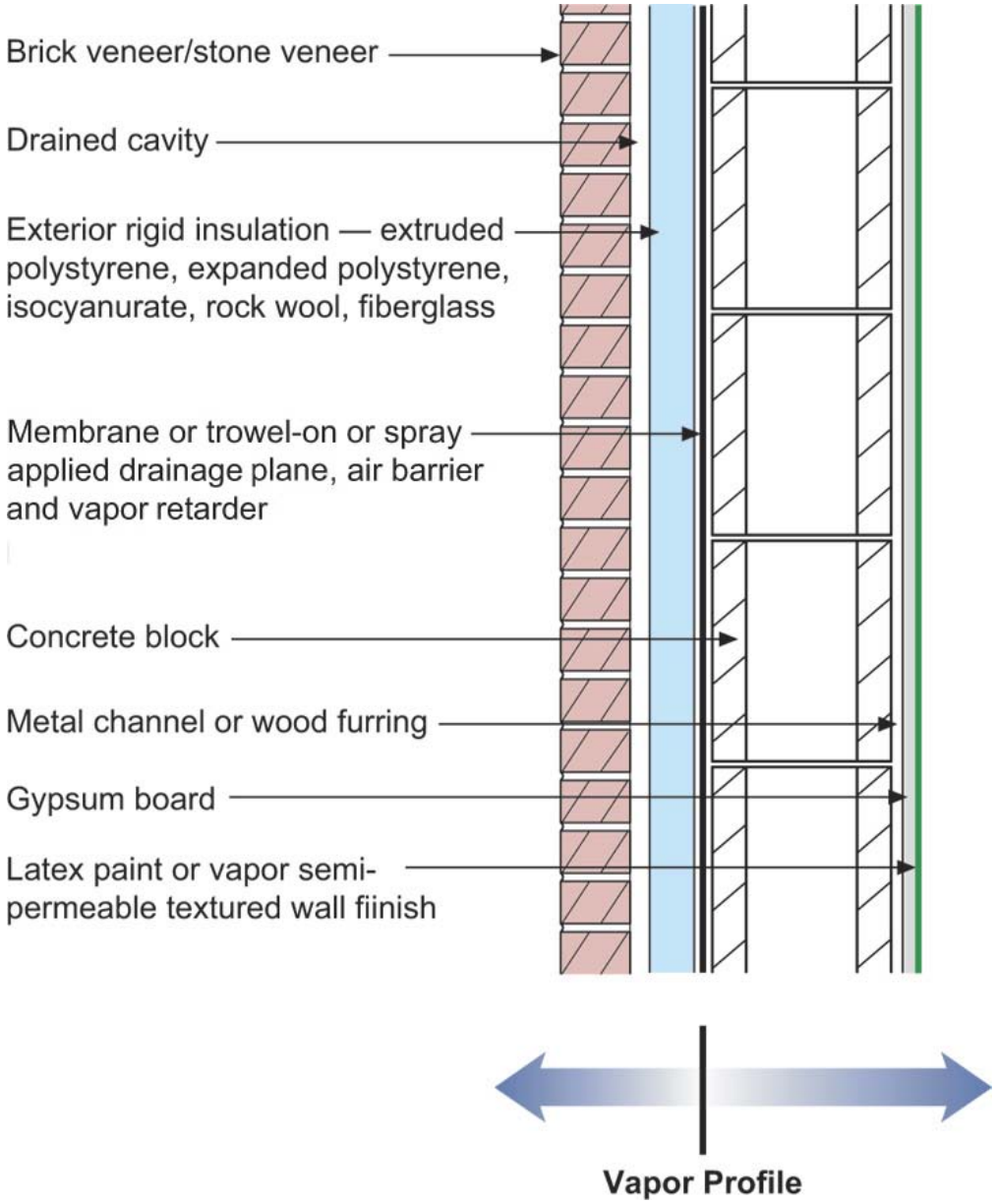


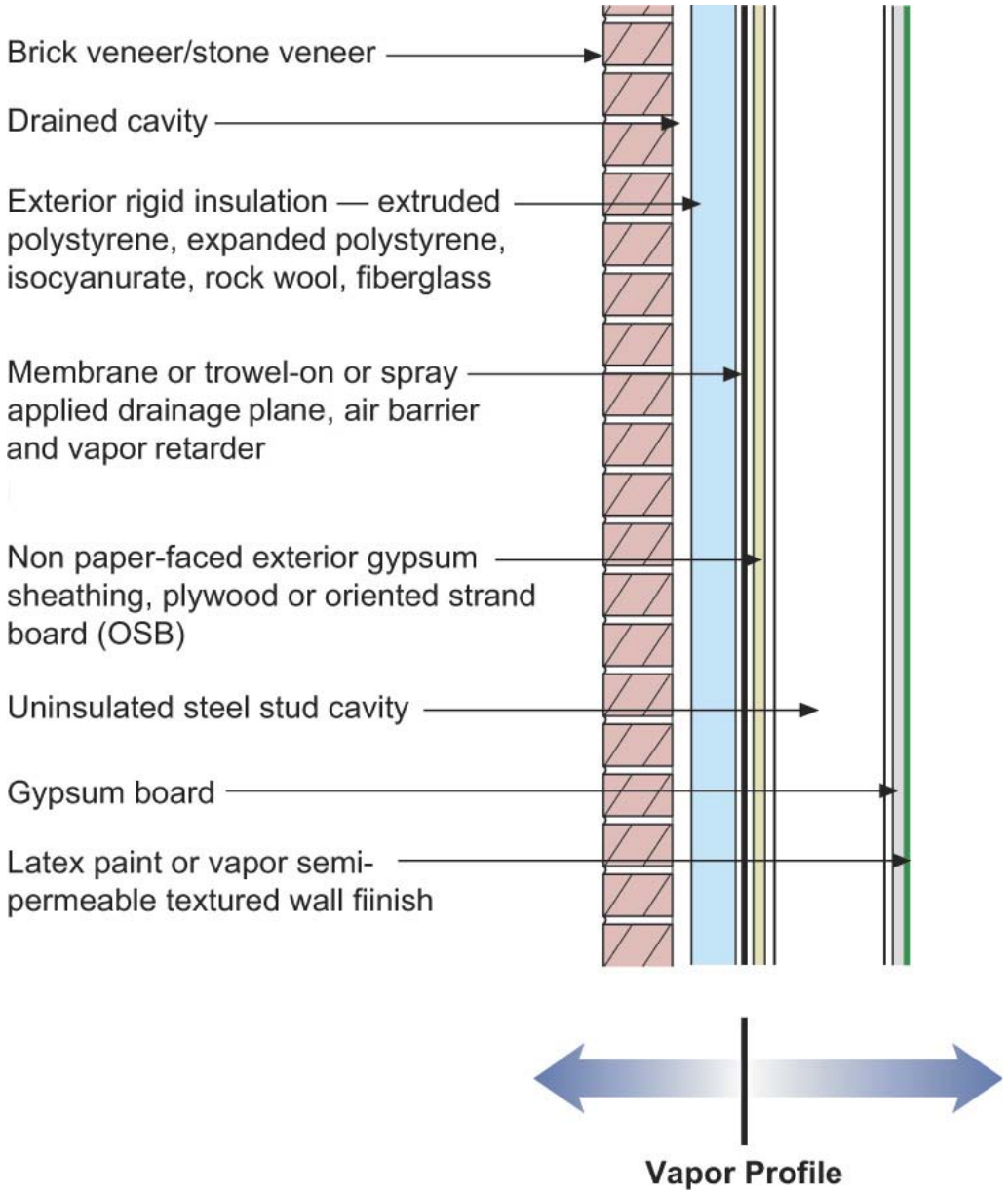
- Structure
- Rain/Air/Vapor
- Insulation
- Finish

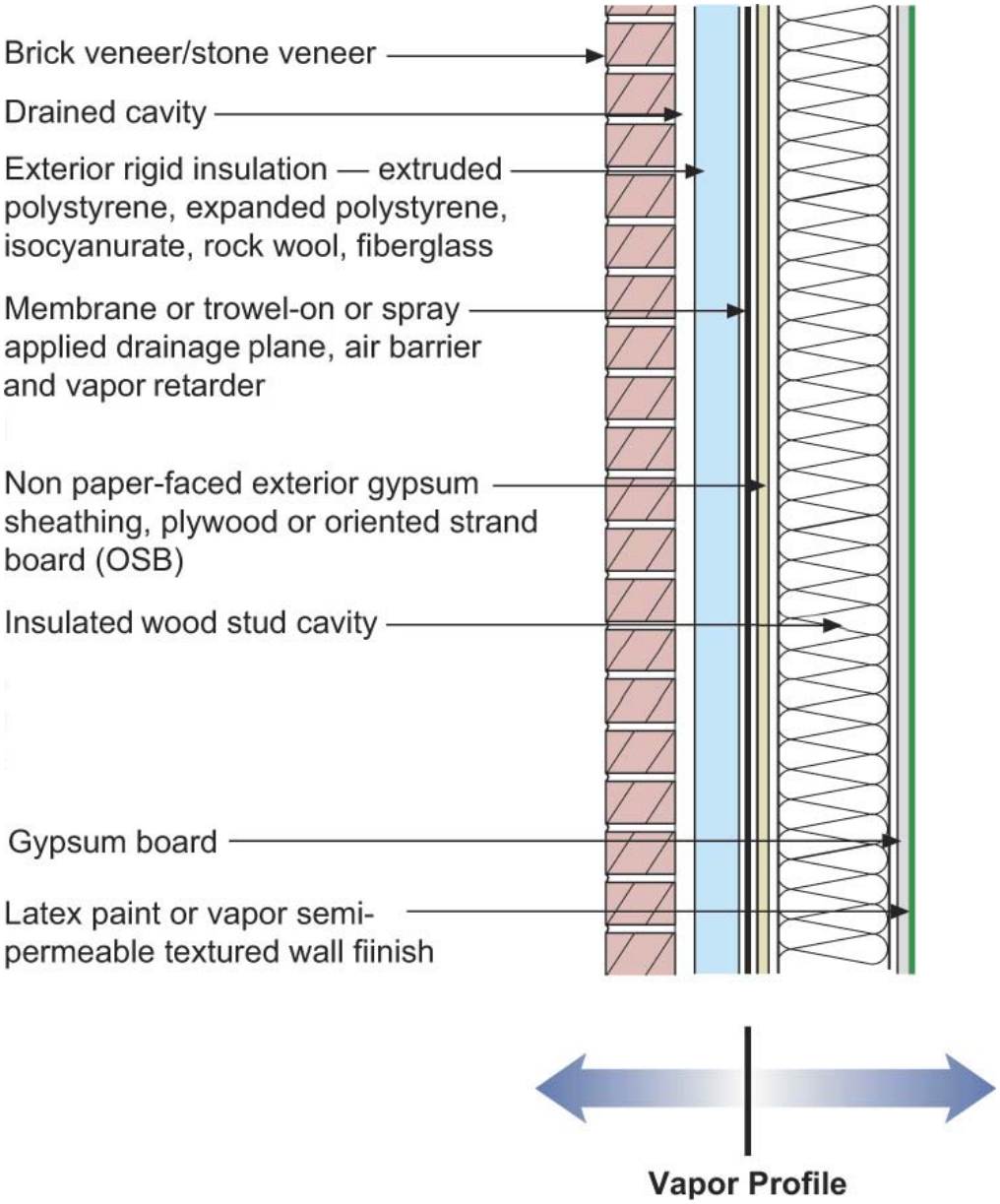
Enclosure Design: Details

- Details demand the same approach as the enclosure.
- Scaled drawings required at

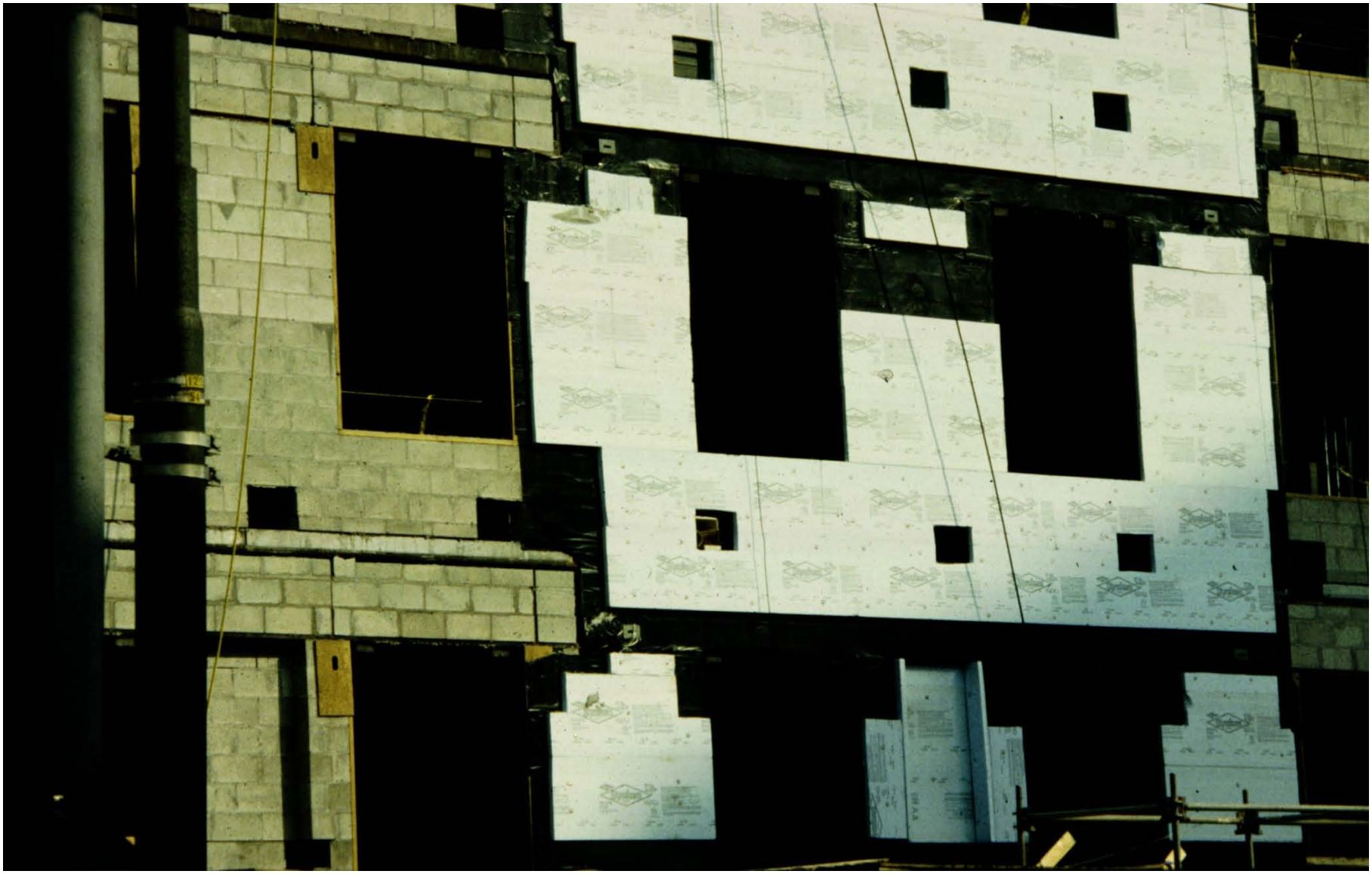



Brick veneer/stone veneer
Drained cavity
Exterior rigid insulation — extruded polystyrene, expanded polystyrene, isocyanurate, rock wool, fiberglass
Membrane or trowel-on or spray applied drainage plane, air barrier and vapor retarder
Concrete block
Metal channel or wood furring
Gypsum board
Latex paint or vapor semi-permeable textured wall fiinish
Vapor Profile


Brick veneer/stone veneer
Drained cavity
Exterior rigid insulation — extruded polystyrene, expanded polystyrene, isocyanurate, rock wool, fiberglass
Membrane or trowel-on or spray applied drainage plane, air barrier and vapor retarder
Non paper-faced exterior gypsum sheathing, plywood or oriented strand board (OSB)
Uninsulated steel stud cavity
Gypsum board
Latex paint or vapor semi-permeable textured wall fiinish
Vapor Profile


Brick veneer/stone veneer
Drained cavity
Exterior rigid insulation — extruded polystyrene, expanded polystyrene, isocyanurate, rock wool, fiberglass
Membrane or trowel-on or spray applied drainage plane, air barrier and vapor retarder
Non paper-faced exterior gypsum sheathing, plywood or oriented strand board (OSB)
Insulated wood stud cavity
Gypsum board
Latex paint or vapor semi-permeable textured wall fiinish
Vapor Profile

J.A.J Co., Inc.
MASONS
781-395-5510
JULION
PURCHASE ST
CONGRESS ST



HARVARD SCHOOL OF PUBLIC HEALTH

ALL VISITORS
MUST SIGN IN
AT
JOHN MORIARTY
AND ASSOCIATES
FIELD OFFICE
CAUTION
HARD HAT
AREA
WORKSITE

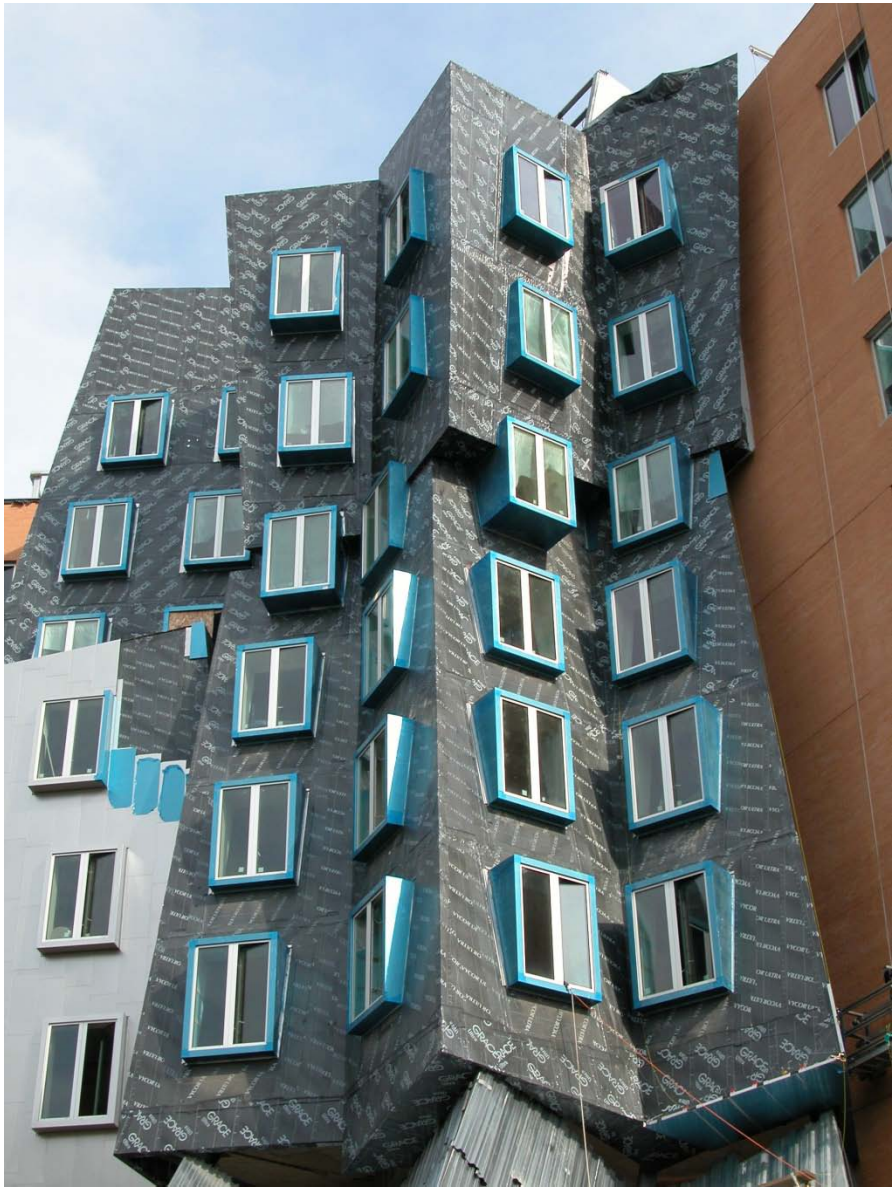
GP
DENSGLASS GOLD

GP
DENSGLASS GOLD
Exterior Sheathing
GP
DENSGLASS GOLD
Exterior Sheathing

Blueskin

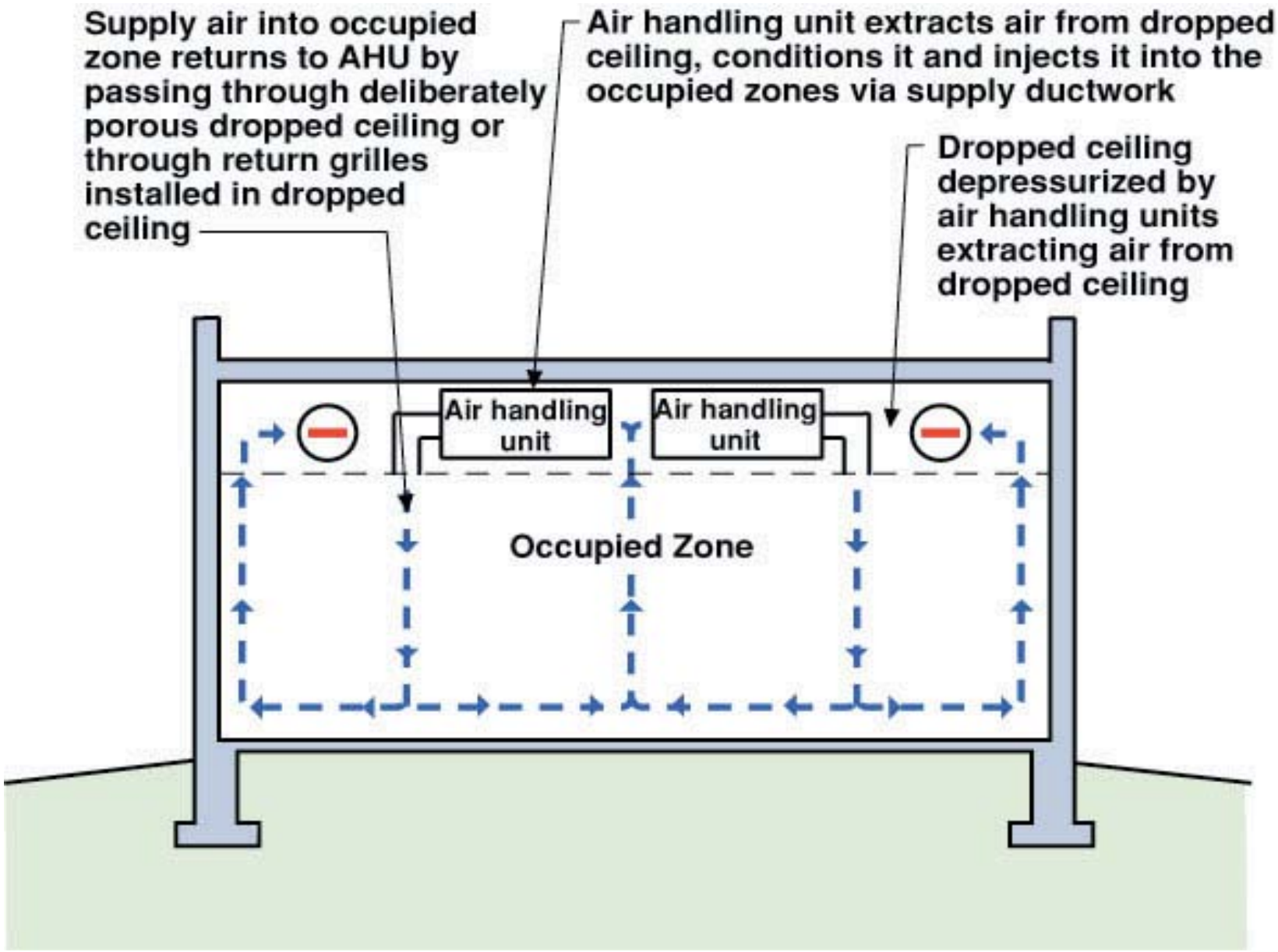
Blueskin
Street Cleaning

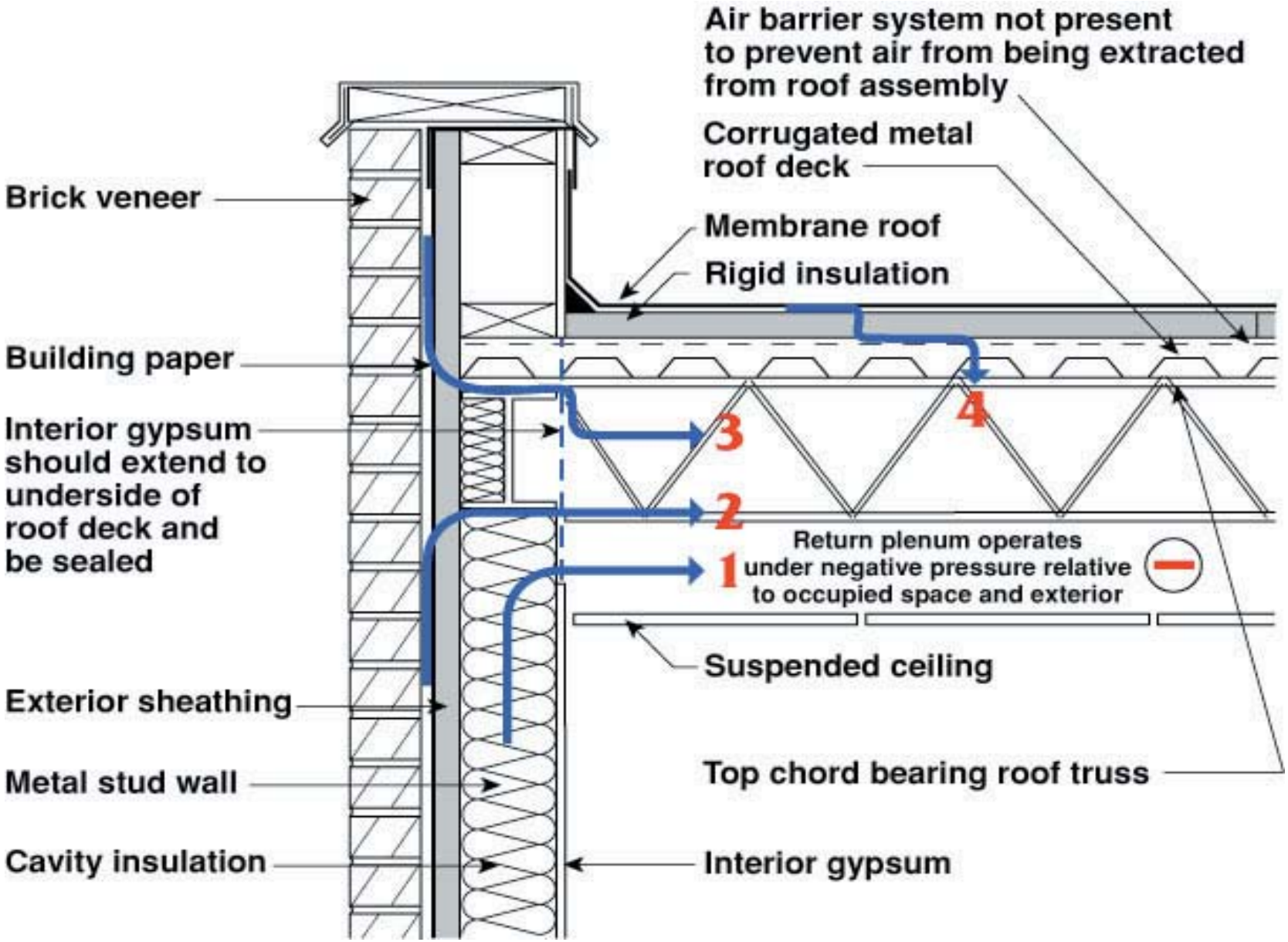
Don’t Do Stupid Things

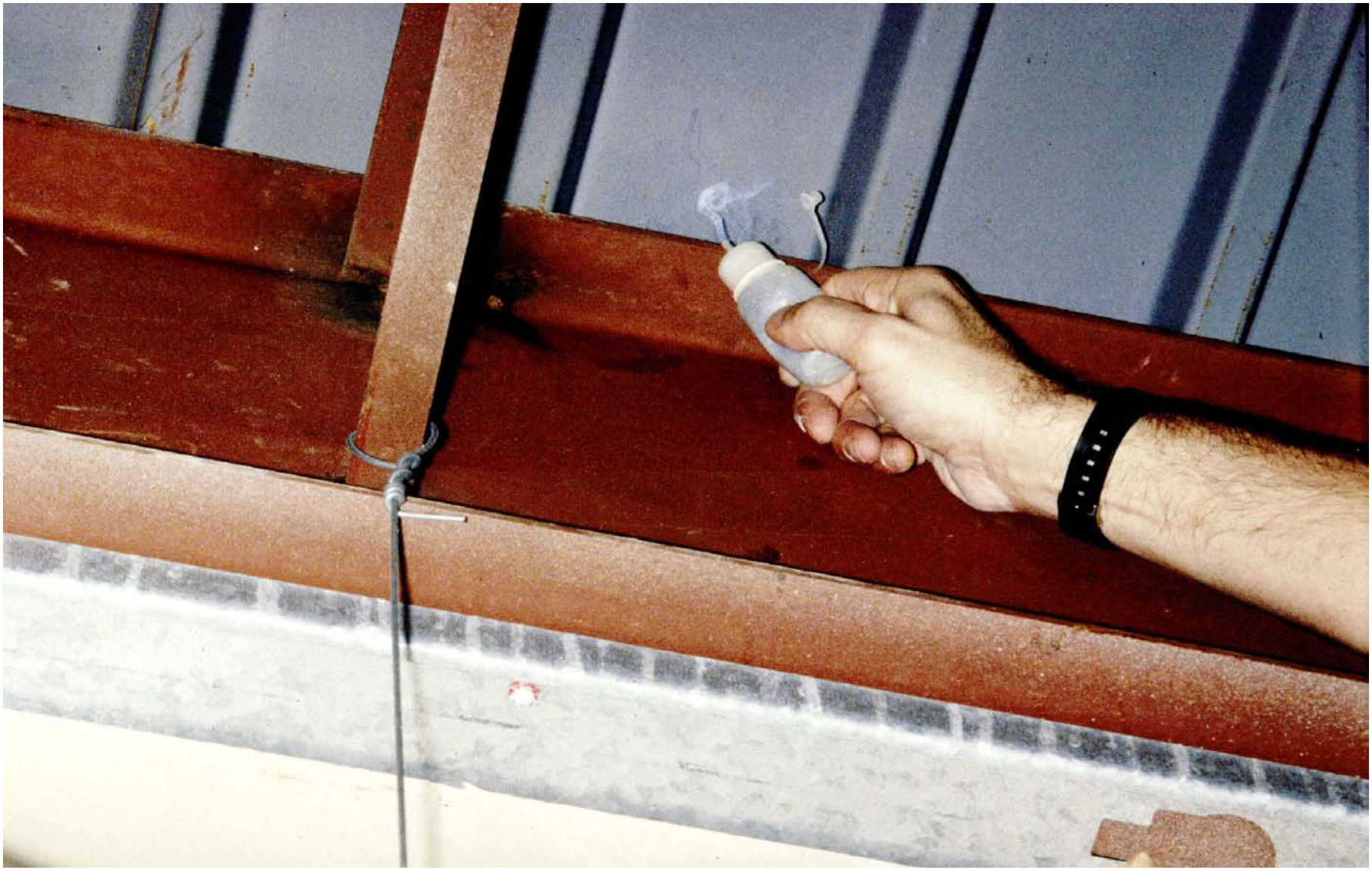


JLG LIFT

W. R. MEADOW
STALIGHT
W. R. MEADOW
STALIGHT
W. R. MEADOW
STALIGHT

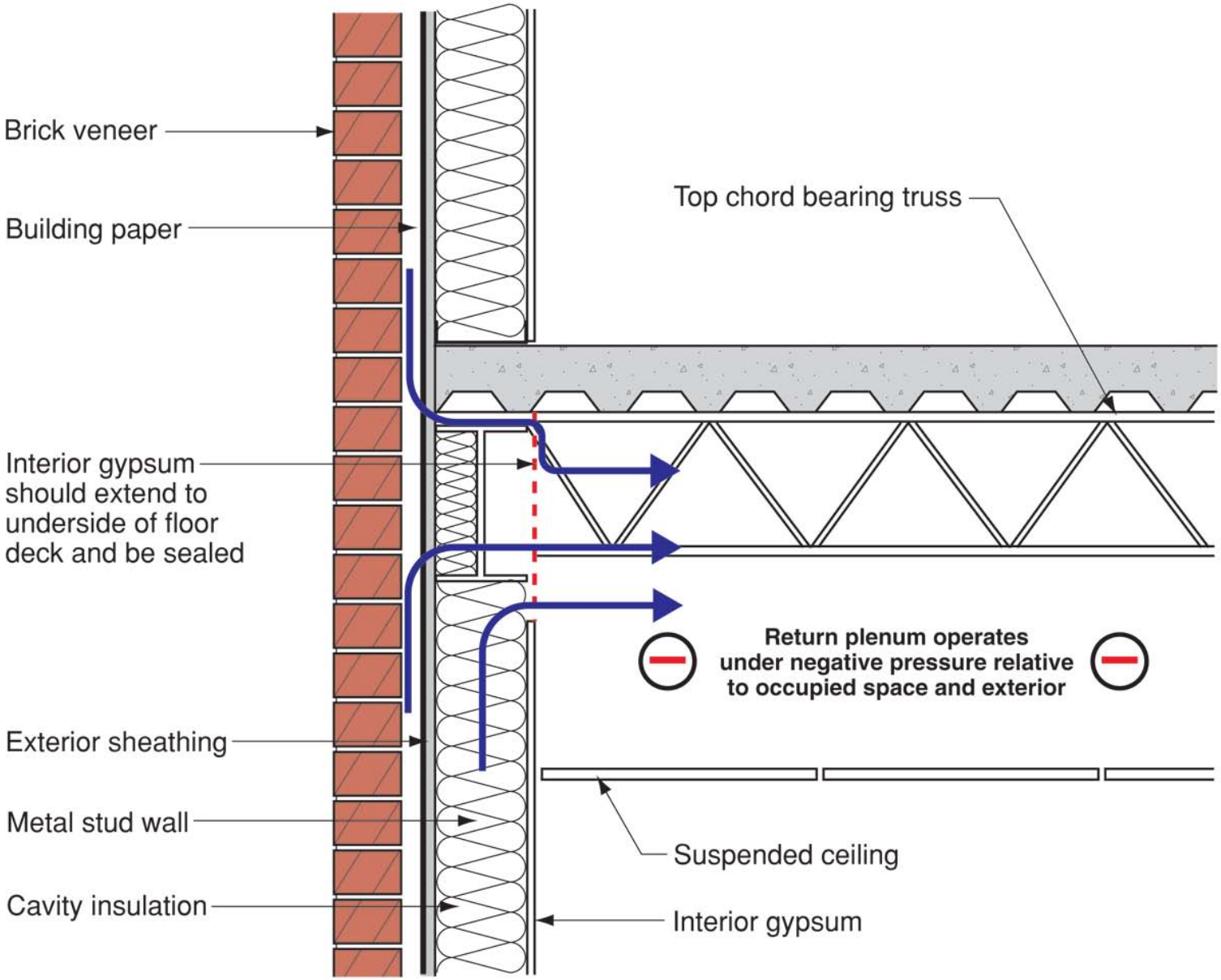

Supply air into occupied zone returns to AHU by passing through deliberately porous dropped ceiling or through return grilles installed in dropped ceiling
Air handling unit extracts air from dropped ceiling, conditions it and injects it into the occupied zones via supply ductwork
Dropped ceiling depressurized by air handling units extracting air from dropped ceiling
Air handling unit
Air handling unit
Occupied Zone

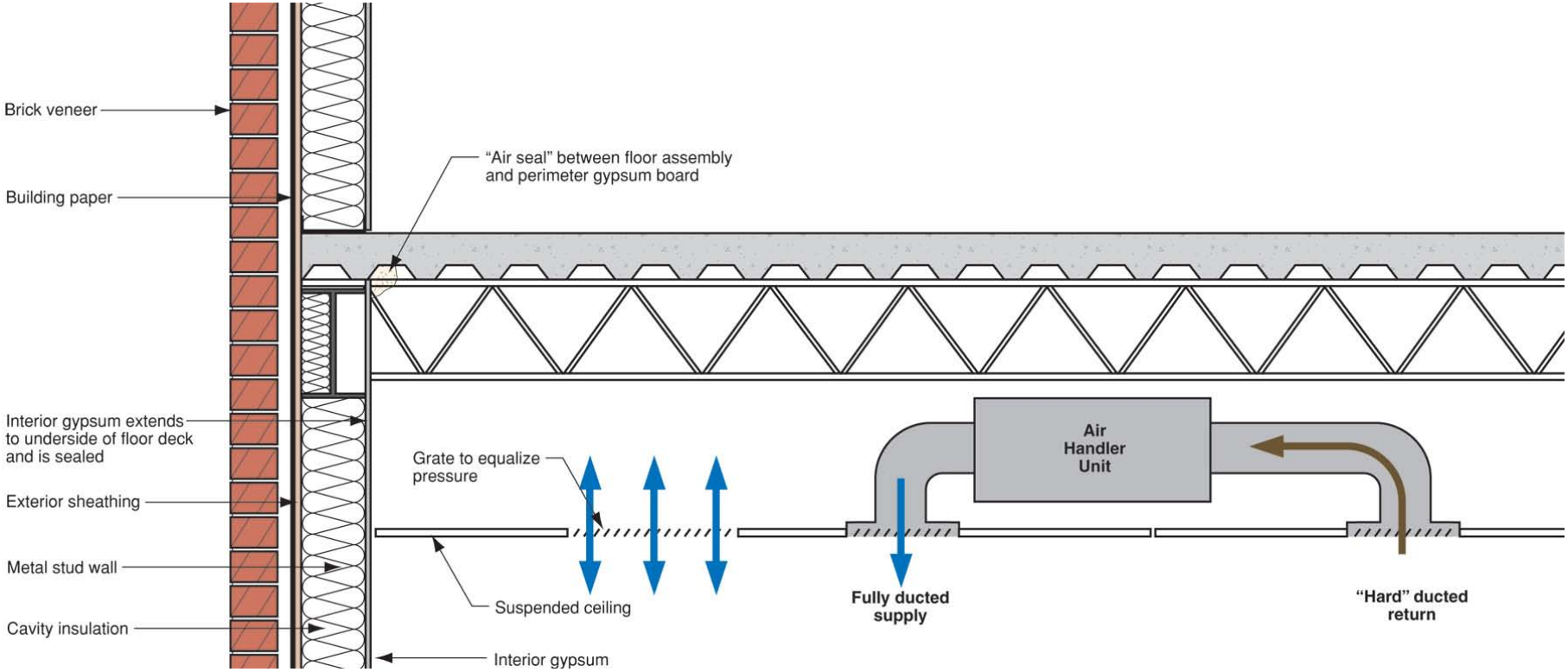

Air barrier system not present to prevent air from being extracted from roof assembly
Corrugated metal roof deck
Brick veneer
Membrane roof
Rigid insulation
Building paper
Interior gypsum should extend to underside of roof deck and be sealed
3
4
2
1
Return plenum operates under negative pressure relative to occupied space and exterior
Suspended ceiling
Exterior sheathing
Top chord bearing roof truss
Metal stud wall
Cavity insulation
Interior gypsum



Tyvek

RE COMPANY


Brick veneer
Building paper
Top chord bearing truss
Interior gypsum should extend to underside of floor deck and be sealed
Return plenum operates under negative pressure relative to occupied space and exterior
Exterior sheathing
Metal stud wall
Suspended ceiling
Cavity insulation
Interior gypsum


Brick veneer
Building paper
"Air seal" between floor assembly and perimeter gypsum board
Interior gypsum extends to underside of floor deck and is sealed
Exterior sheathing
Metal stud wall
Cavity insulation
Grate to equalize pressure
Suspended ceiling
Interior gypsum
Air Handler Unit
Fully ducted supply
"Hard" ducted return

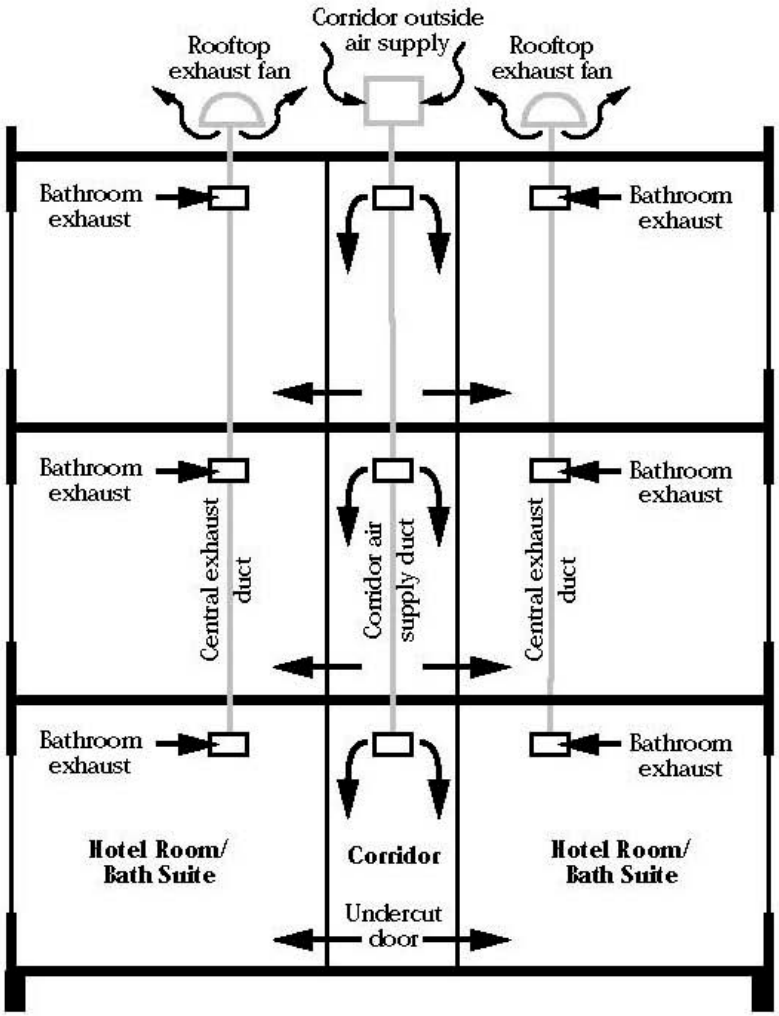
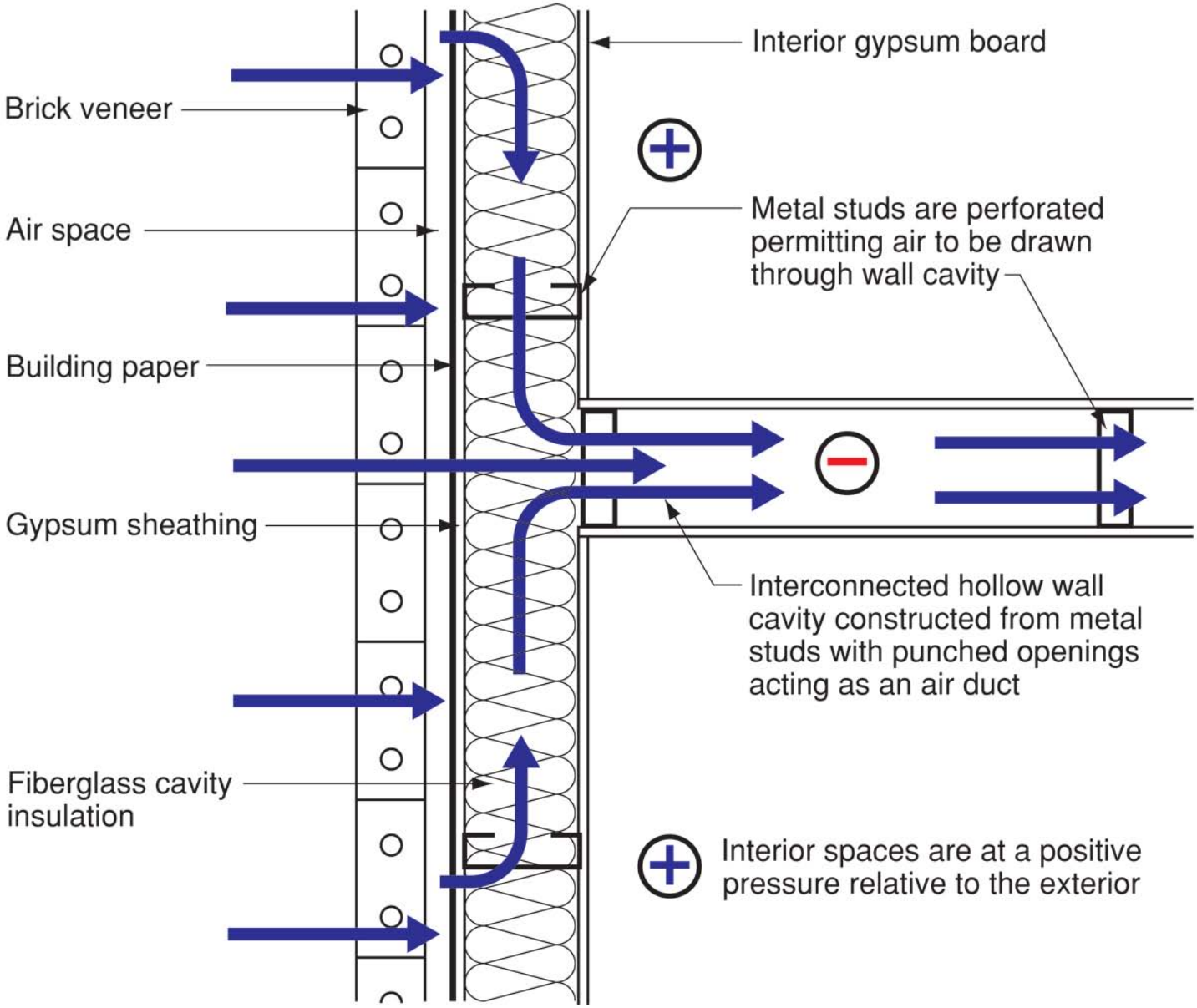


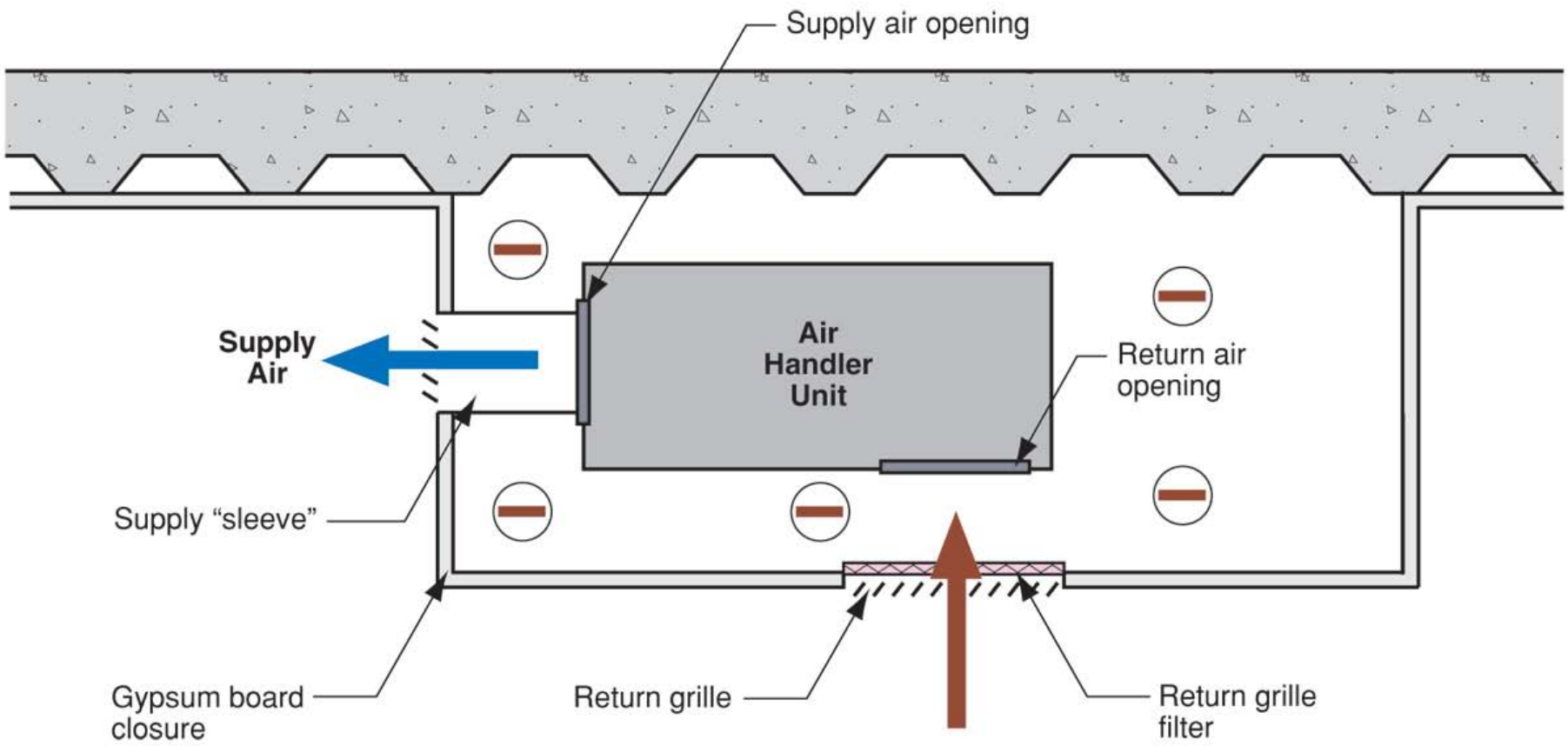
Figure 3.8

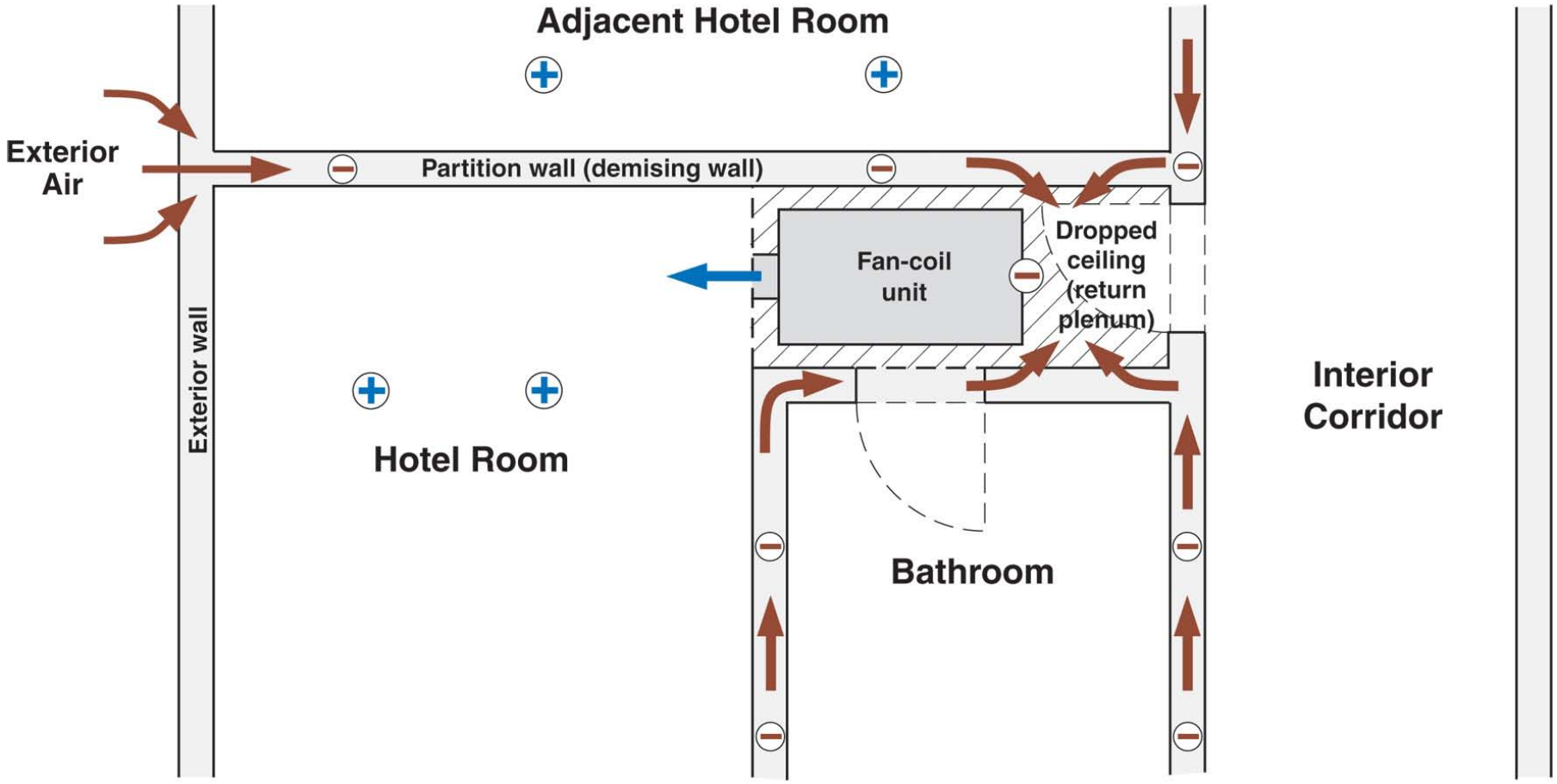
Hotel HVAC System

- Air exhausted from bathrooms via central rooftop exhaust fans
- Air supplied from corridors via undercut doors

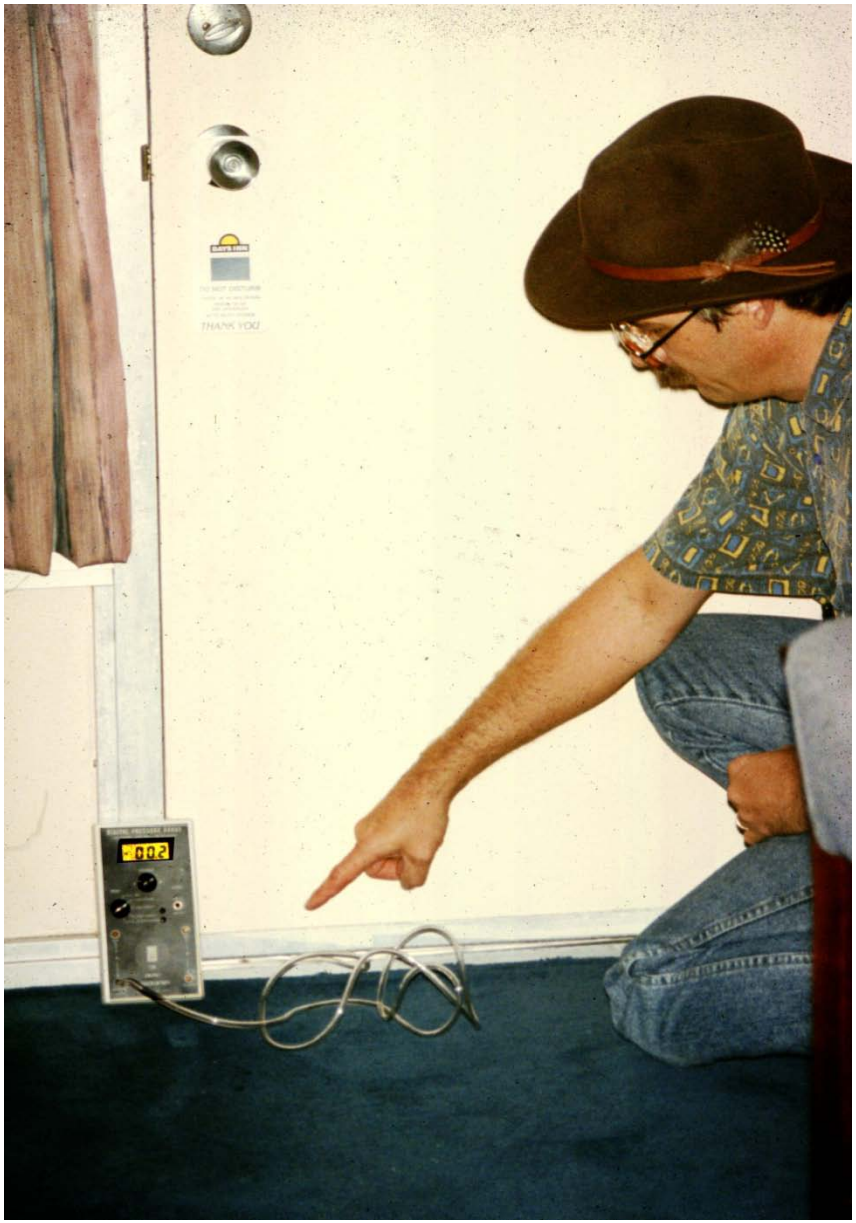
Zenith

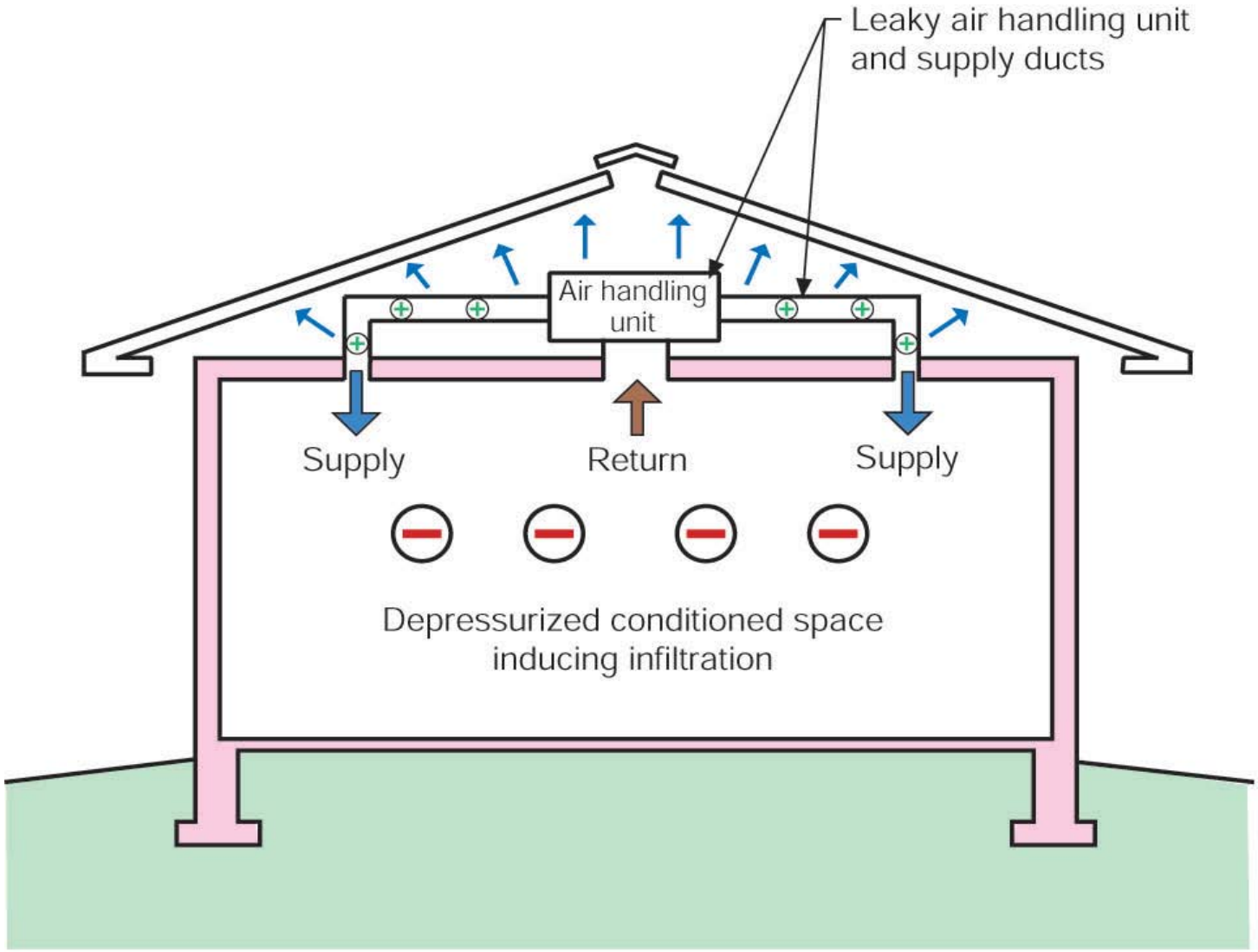

Interior gypsum board
Brick veneer
Air space
Metal studs are perforated permitting air to be drawn through wall cavity
Building paper
Gypsum sheathing
Interconnected hollow wall cavity constructed from metal studs with punched openings acting as an air duct
Fiberglass cavity insulation
Interior spaces are at a positive pressure relative to the exterior


Supply air opening
Supply Air
Air Handler Unit
Return air opening
Supply "sleeve"
Gypsum board closure
Return grille
Return grille filter

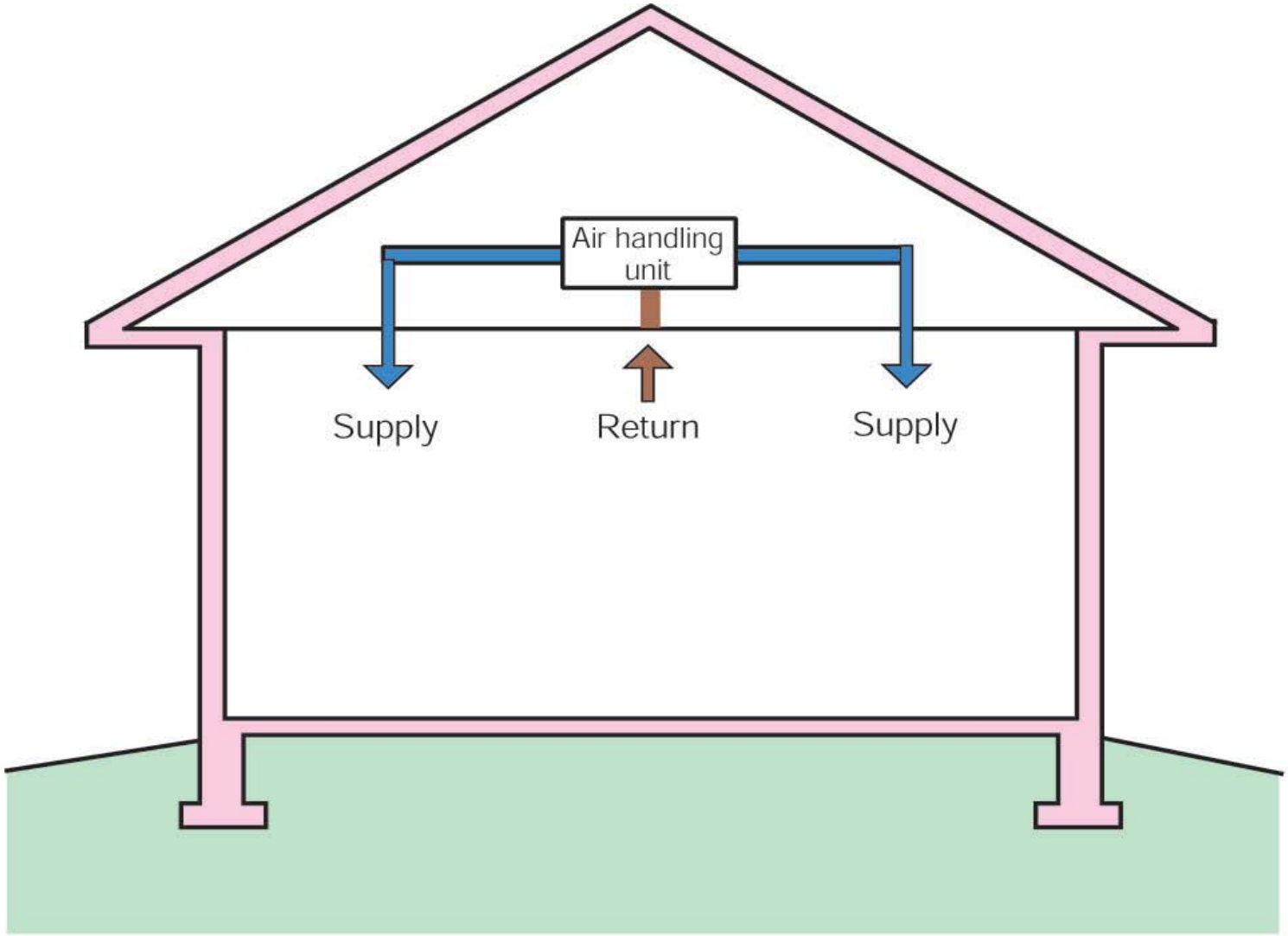

Adjacent Hotel Room
Exterior Air
Partition wall (demising wall)
Fan-coil unit
Dropped ceiling (return plenum)
Exterior wall
Hotel Room
Interior Corridor
Bathroom

DAYS INN

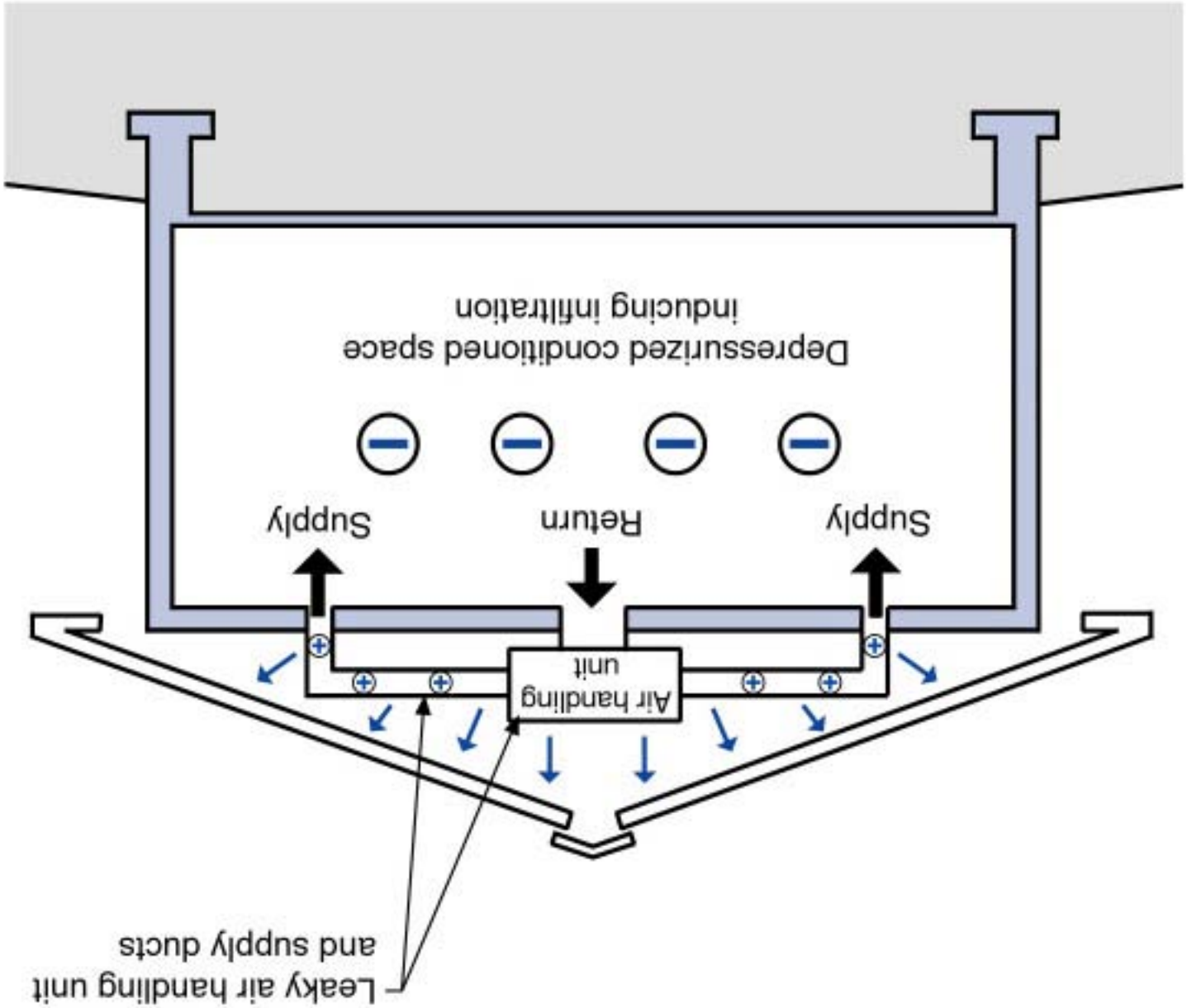

THANK YOU
-.002

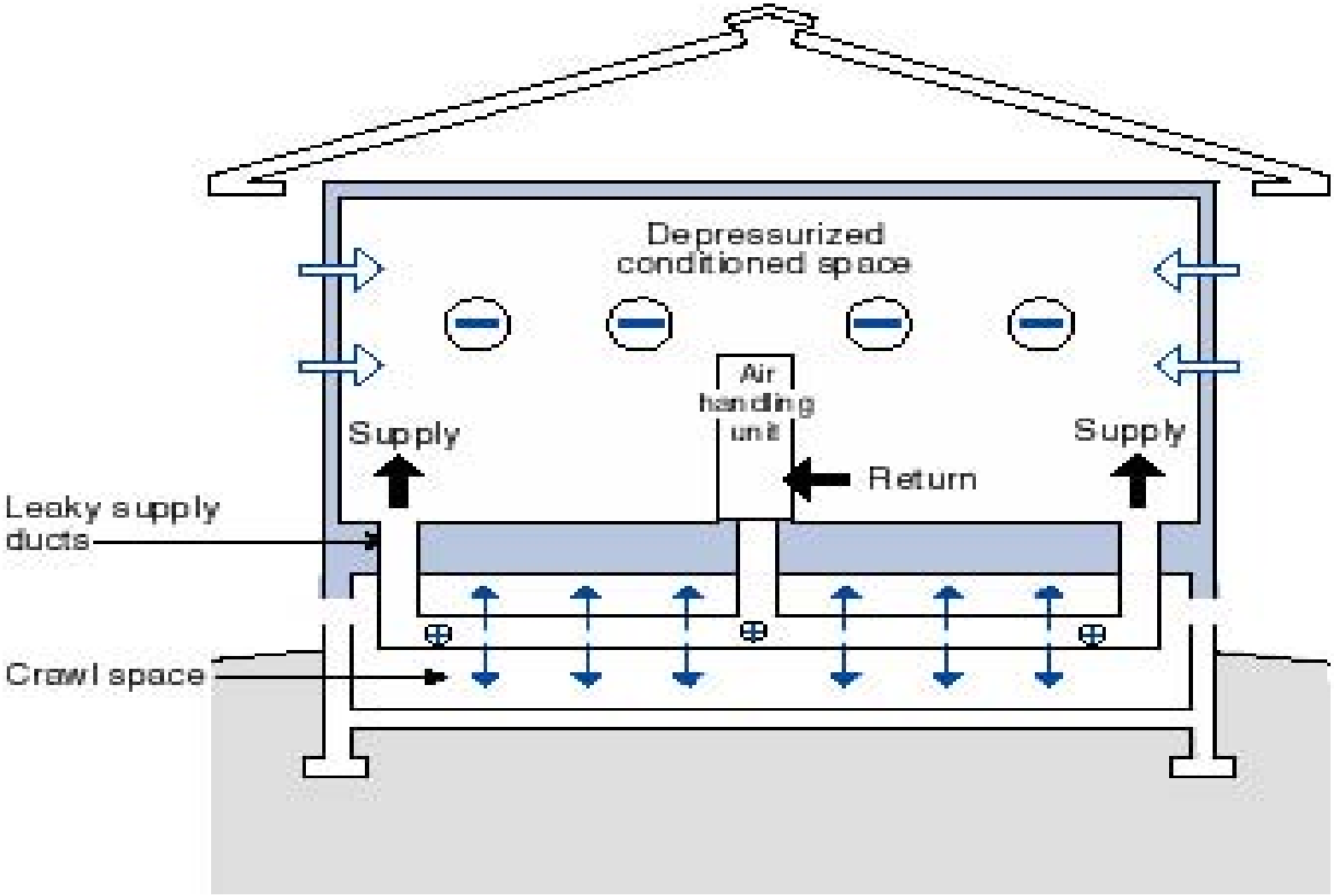


Note: Colored shading depicts the building's thermal barrier and pressure boundary. The thermal barrier and pressure boundary enclose the conditioned space.

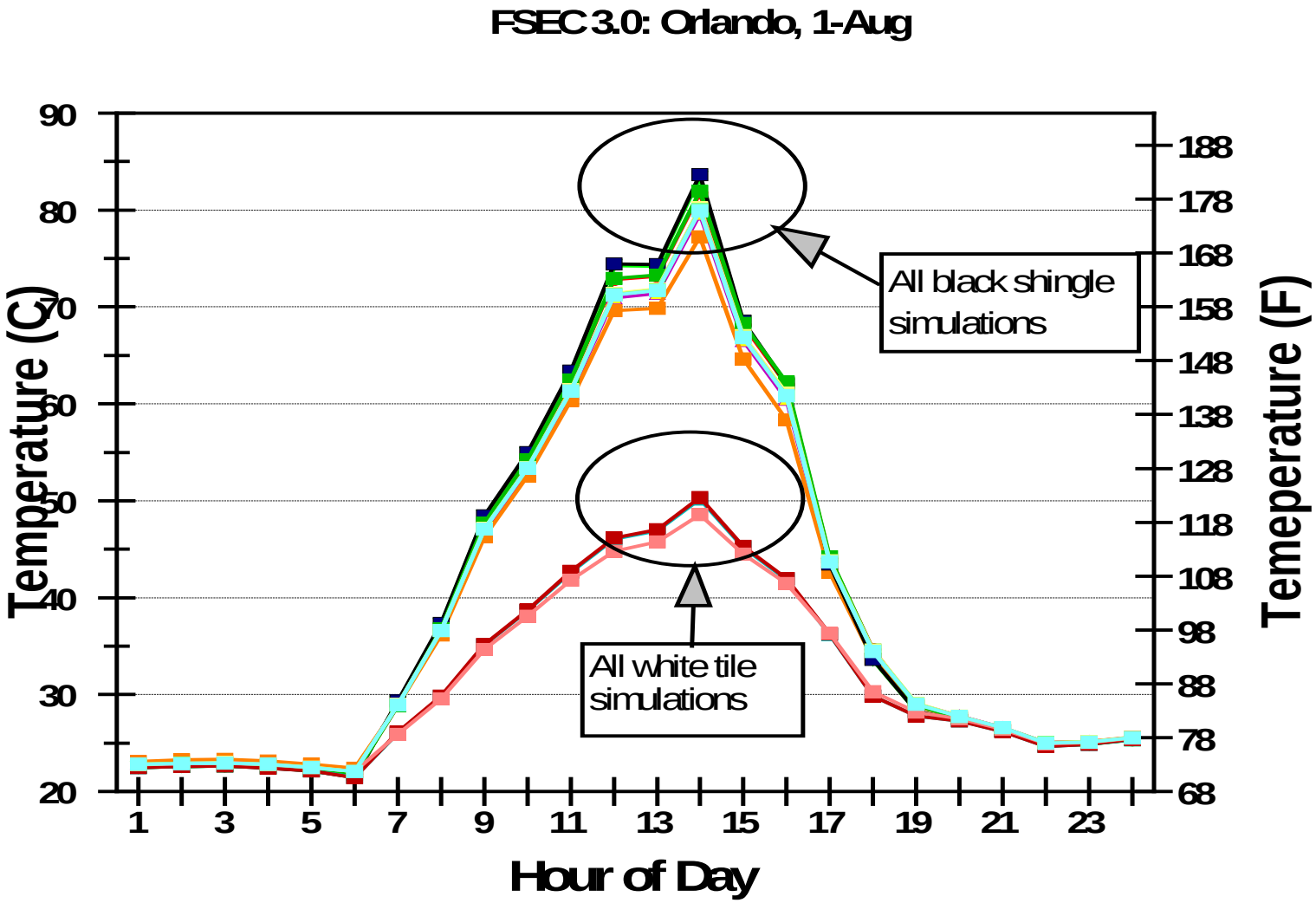


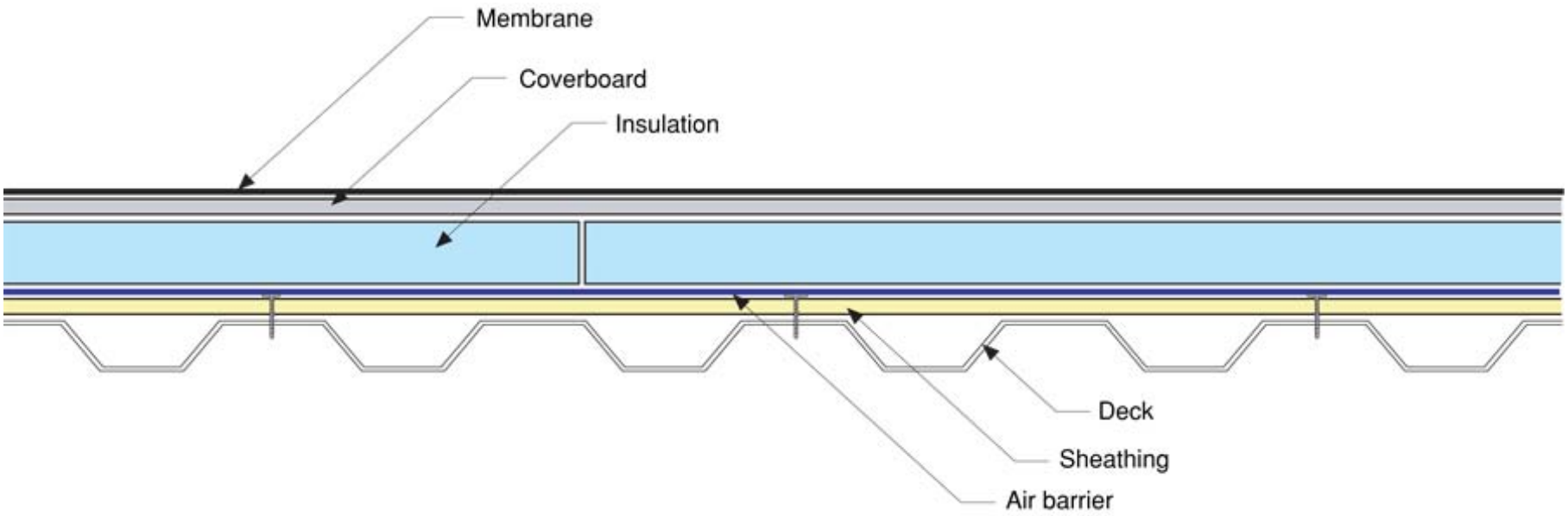
Note: Colored shading depicts the building's thermal barrier and pressure boundary. The thermal barrier and pressure boundary enclose the conditioned space.

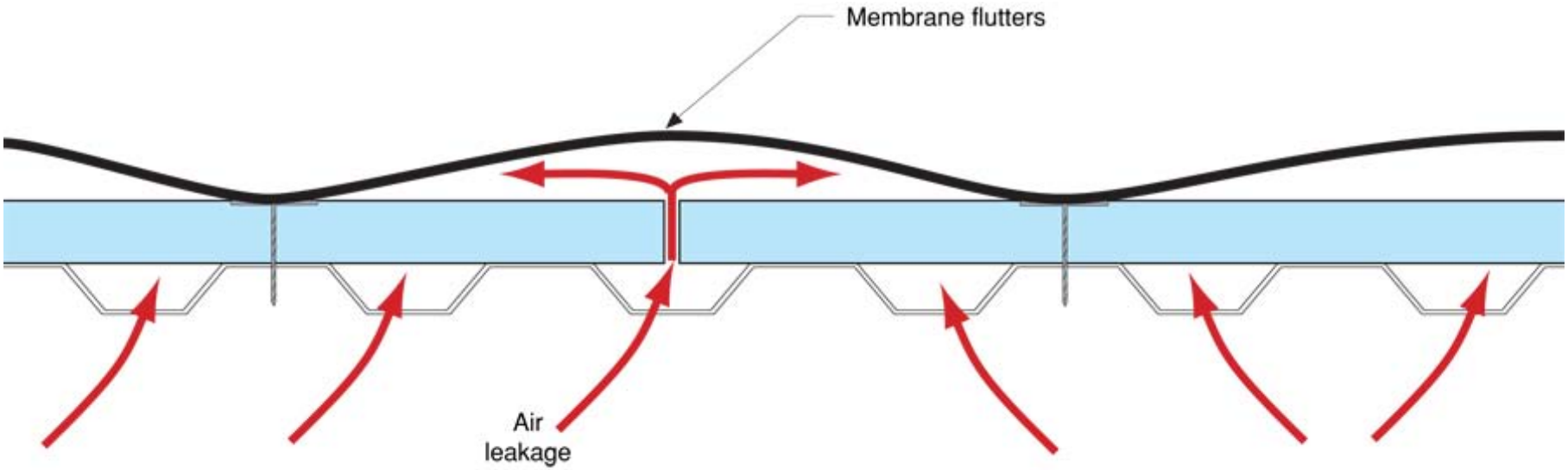

Leaky air handling unit
and supply ducts
Air handling
unit
Supply
Return
Supply
Depressurized conditioned space
inducing infiltration


Depressurized
conditioned space
Air
handling
unit
Supply
Supply
Return
Leaky supply
ducts
Crawl space

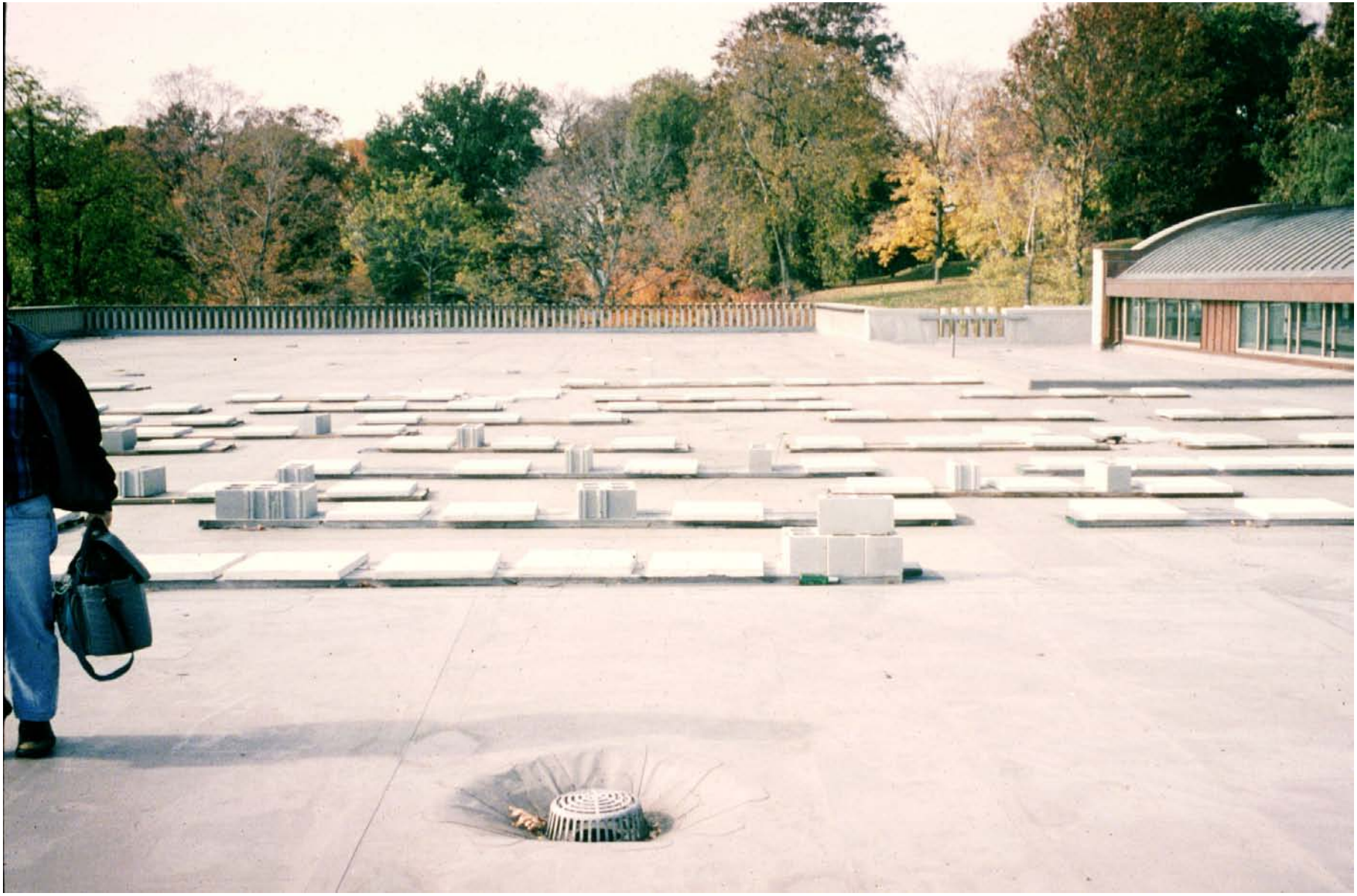
Roof Shingle Temperature

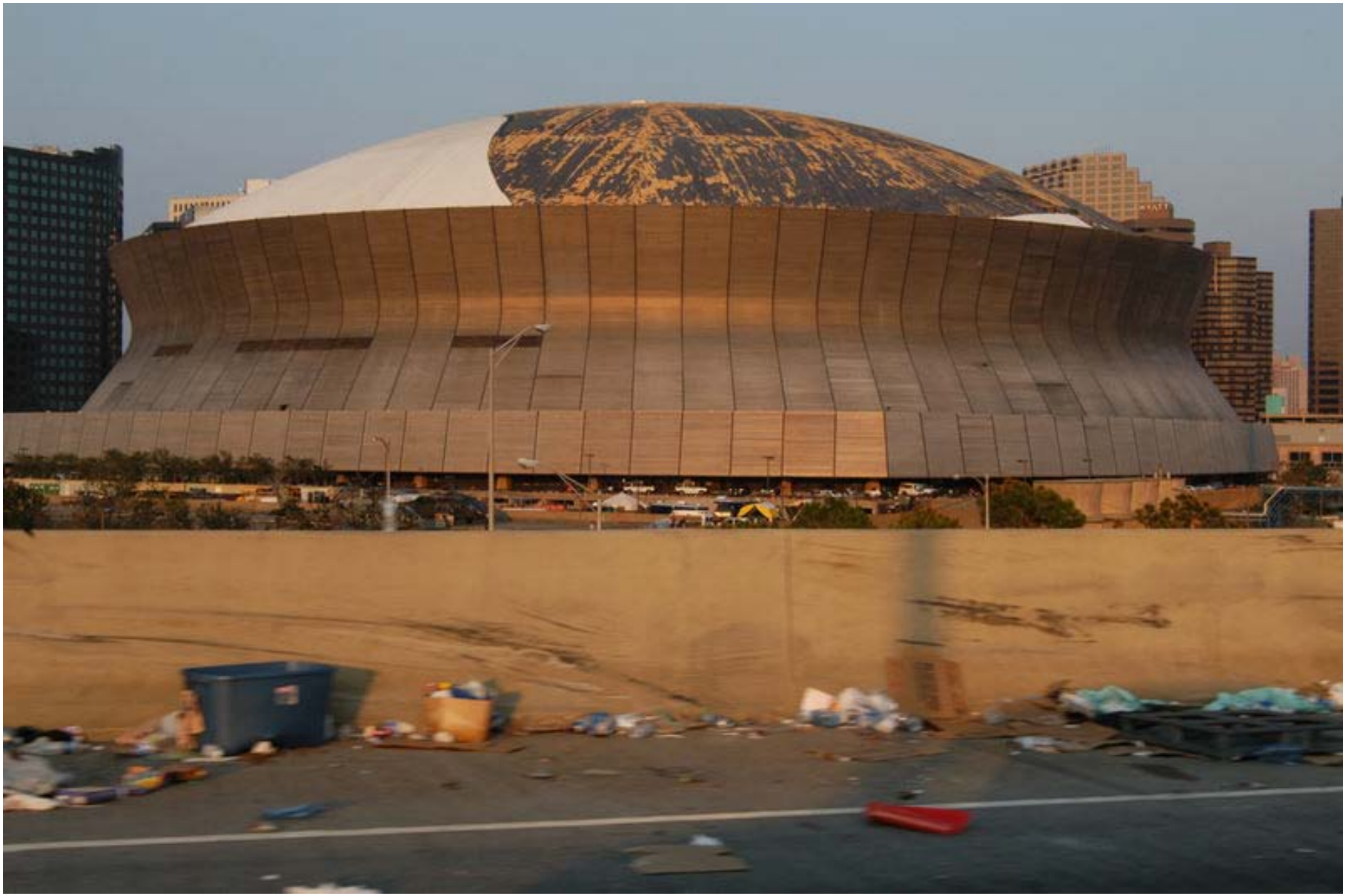


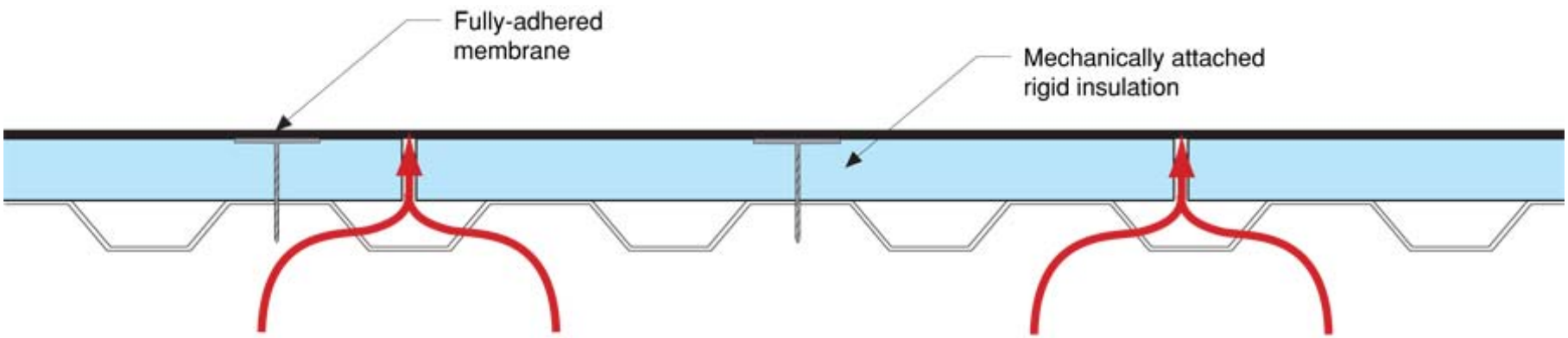

Membrane
Coverboard
Insulation
Deck
Sheathing
Air barrier

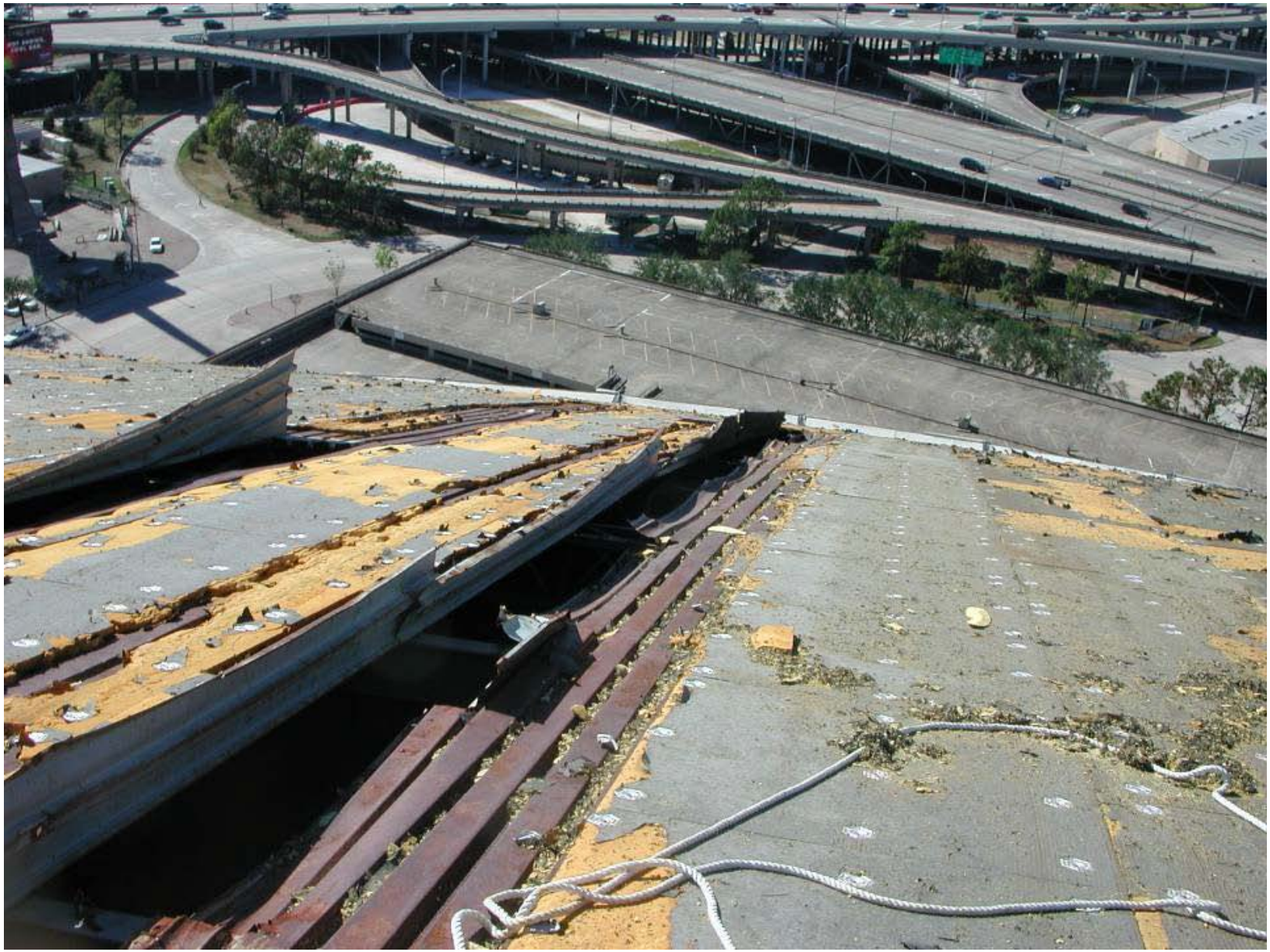

Membrane flutters
Air
leakage

THE TISCH LIBRARY

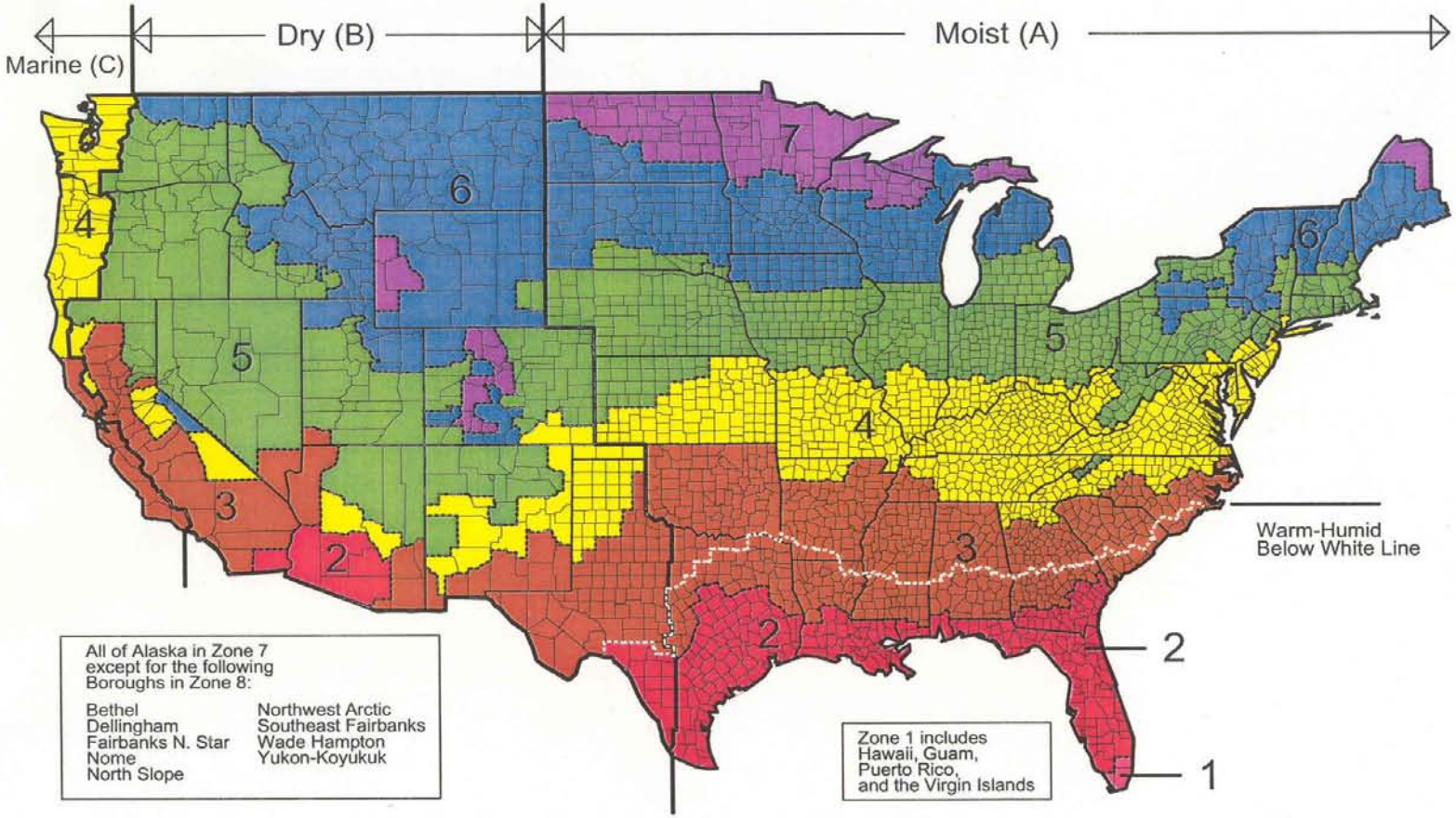




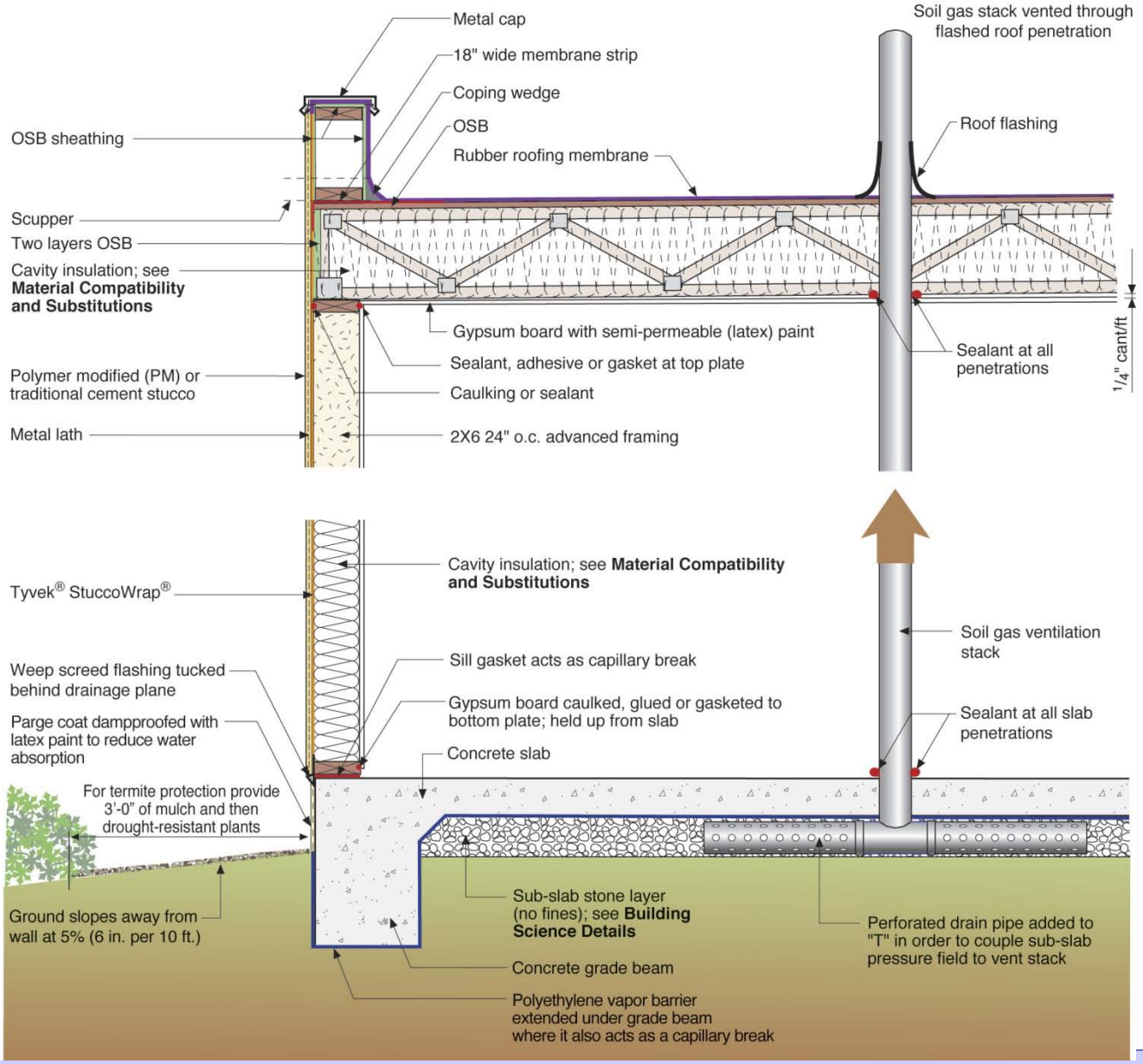

Fully-adhered
membrane
Mechanically attached
rigid insulation

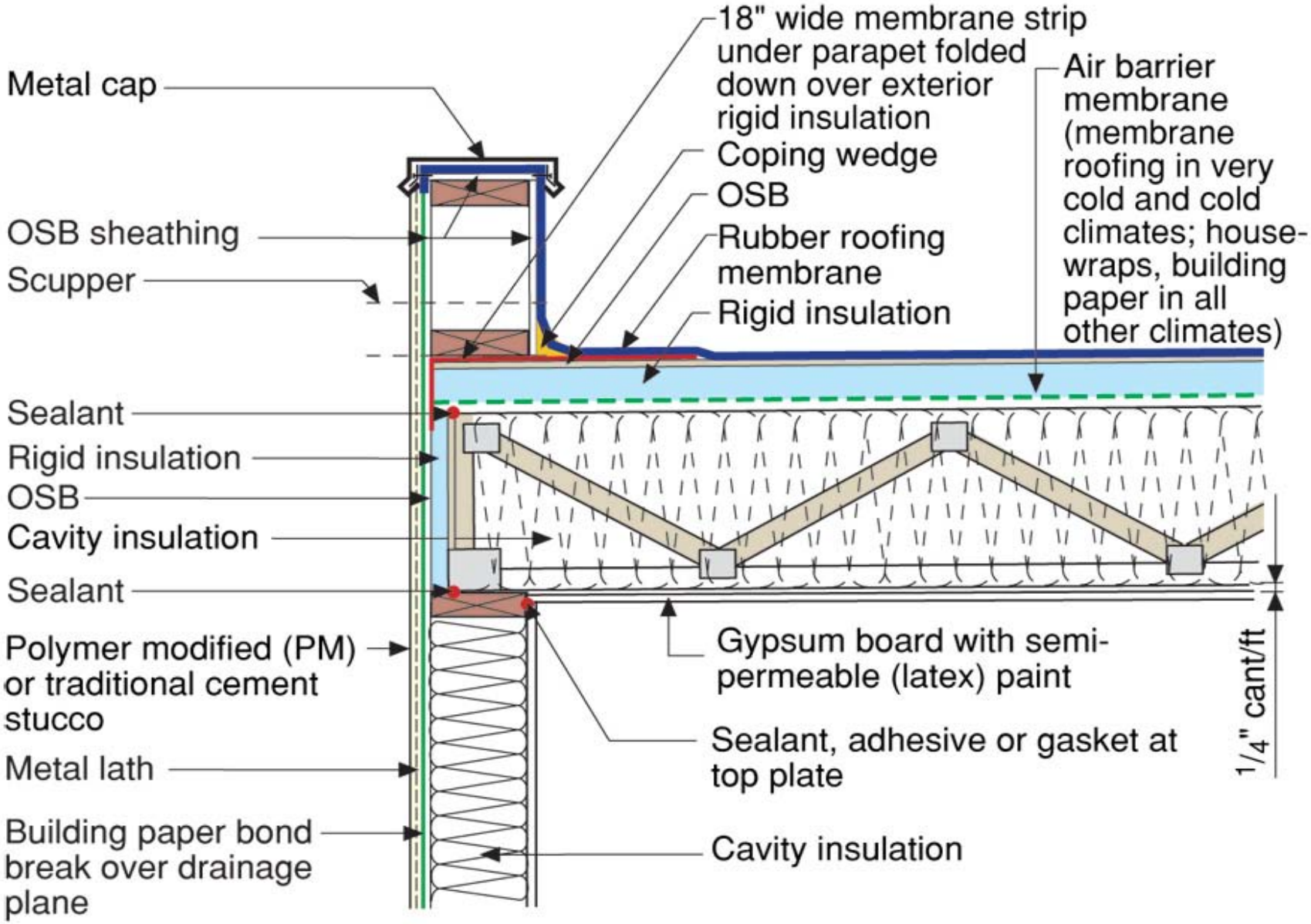


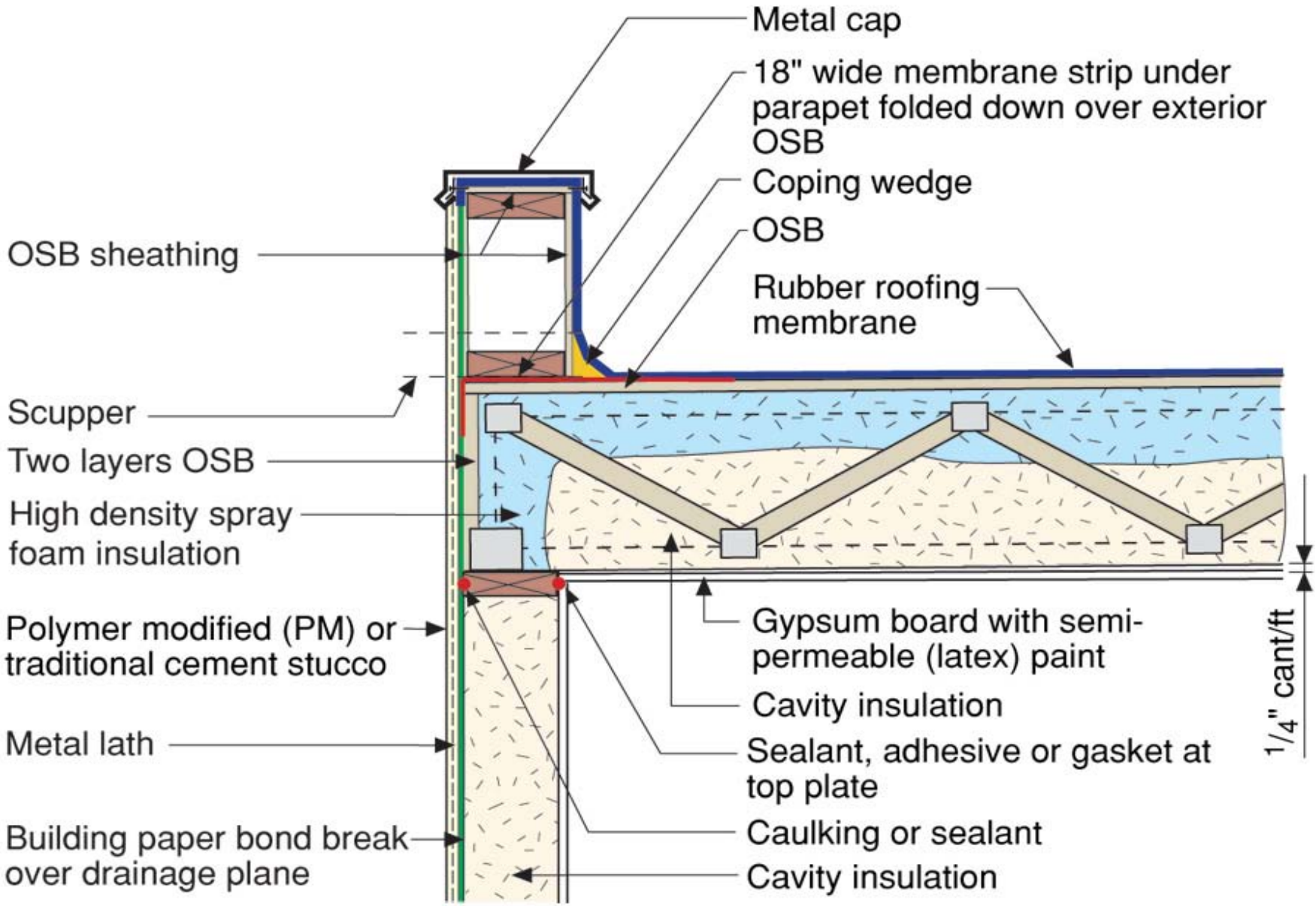
Map of DOE's Proposed Climate Zones



March 24, 2003


Metal cap
18" wide membrane strip
Coping wedge
OSB
Rubber roofing membrane
OSB sheathing
Scupper
Two layers OSB
Cavity insulation; see **Material Compatibility and Substitutions**
Polymer modified (PM) or traditional cement stucco
Metal lath
Soil gas stack vented through flashed roof penetration
Roof flashing
Gypsum board with semi-permeable (latex) paint
Sealant, adhesive or gasket at top plate
Caulking or sealant
2X6 24" o.c. advanced framing
Sealant at all penetrations
1/4" cant/ft
Tyvek® StuccoWrap®
Cavity insulation; see **Material Compatibility and Substitutions**
Weep screed flashing tucked behind drainage plane
Parge coat dampproofed with latex paint to reduce water absorption
Sill gasket acts as capillary break
Gypsum board caulked, glued or gasketed to bottom plate; held up from slab
Concrete slab
Soil gas ventilation stack
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); see **Building Science Details**
Concrete grade beam
Polyethylene vapor barrier extended under grade beam where it also acts as a capillary break
Perforated drain pipe added to "T" in order to couple sub-slab pressure field to vent stack


Metal cap
OSB sheathing
Scupper
Sealant
Rigid insulation
OSB
Cavity insulation
Sealant
Polymer modified (PM) or traditional cement stucco
Metal lath
Building paper bond break over drainage plane
18" wide membrane strip under parapet folded down over exterior rigid insulation
Coping wedge
OSB
Rubber roofing membrane
Rigid insulation
Air barrier membrane (membrane roofing in very cold and cold climates; house-wraps, building paper in all other climates)
Gypsum board with semi-permeable (latex) paint
Sealant, adhesive or gasket at top plate
Cavity insulation
1/4" cant/ft


Metal cap
18" wide membrane strip under parapet folded down over exterior OSB
Coping wedge
OSB
Rubber roofing membrane
OSB sheathing
Scupper
Two layers OSB
High density spray foam insulation
Polymer modified (PM) or traditional cement stucco
Metal lath
Building paper bond break over drainage plane
Gypsum board with semi-permeable (latex) paint
Cavity insulation
Sealant, adhesive or gasket at top plate
Caulking or sealant
Cavity insulation
1/4" cant/ft