

Physical Environmental Factors

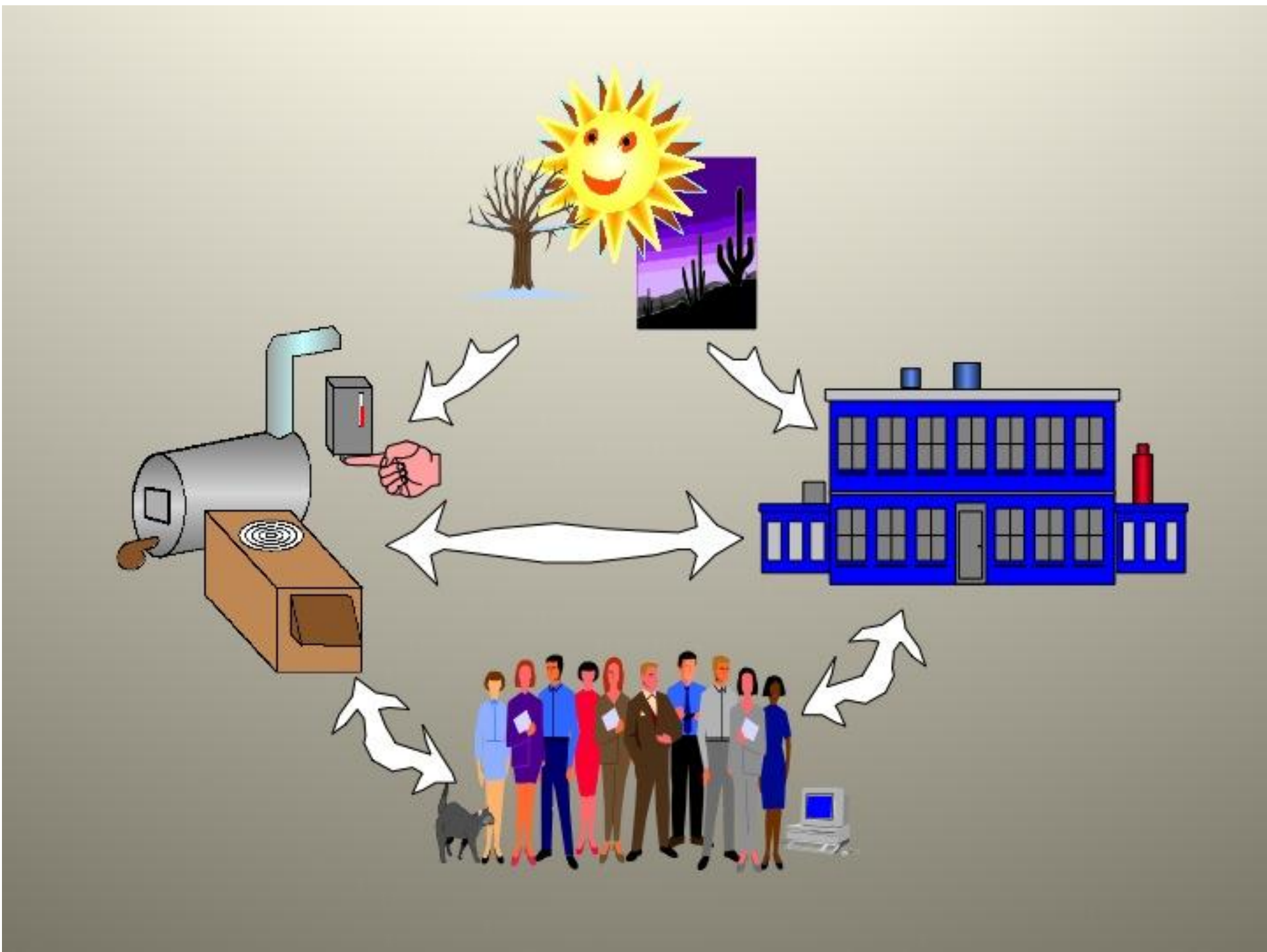
- How Buildings Work
- Importance of Ventilation
On Learning
- Moisture Control

How Buildings Work





Do To The *Cold* Weather
Please Leave The Faucets
Running



**Remember who
you designing
for...**

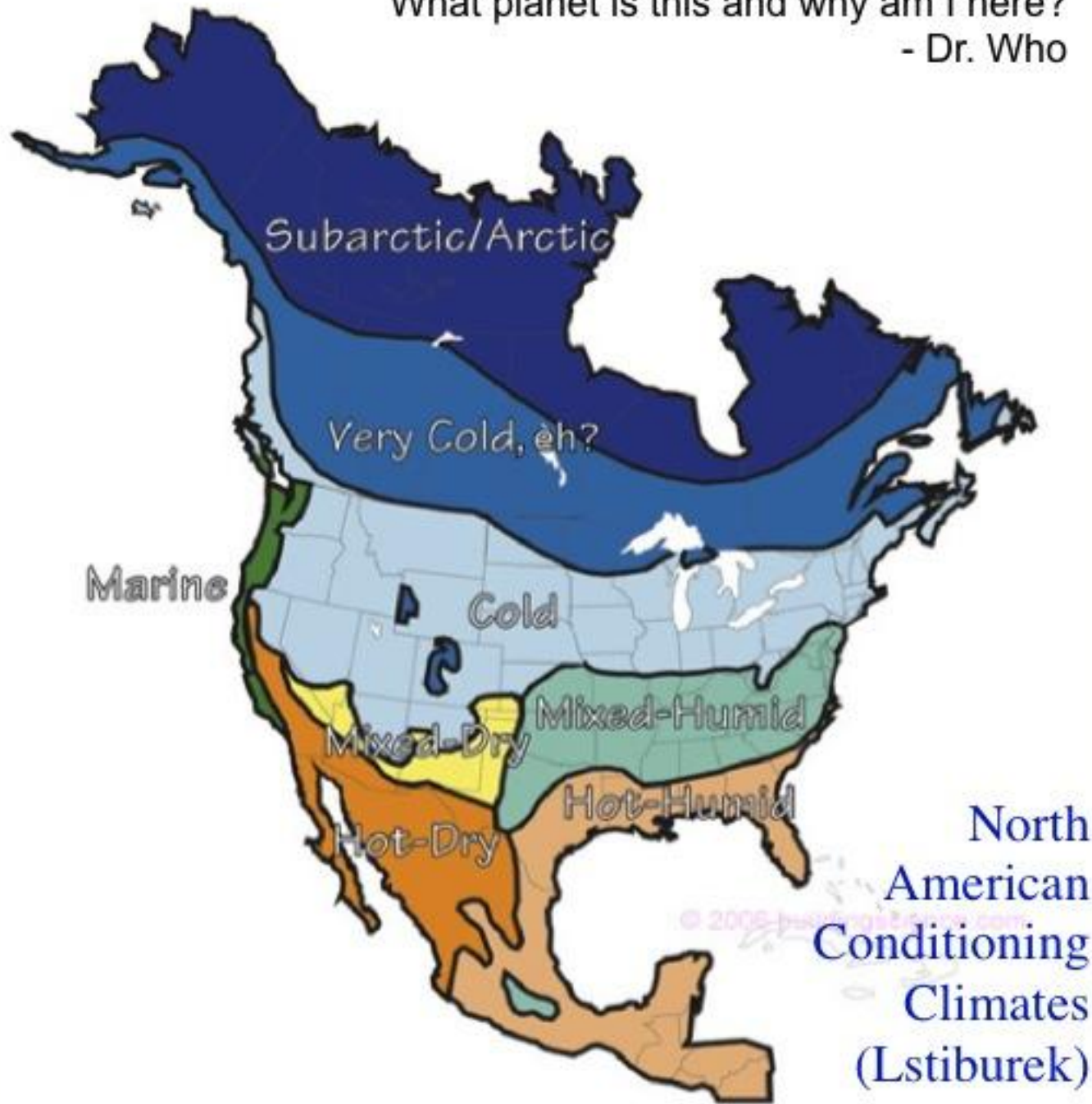


Indoor Climate

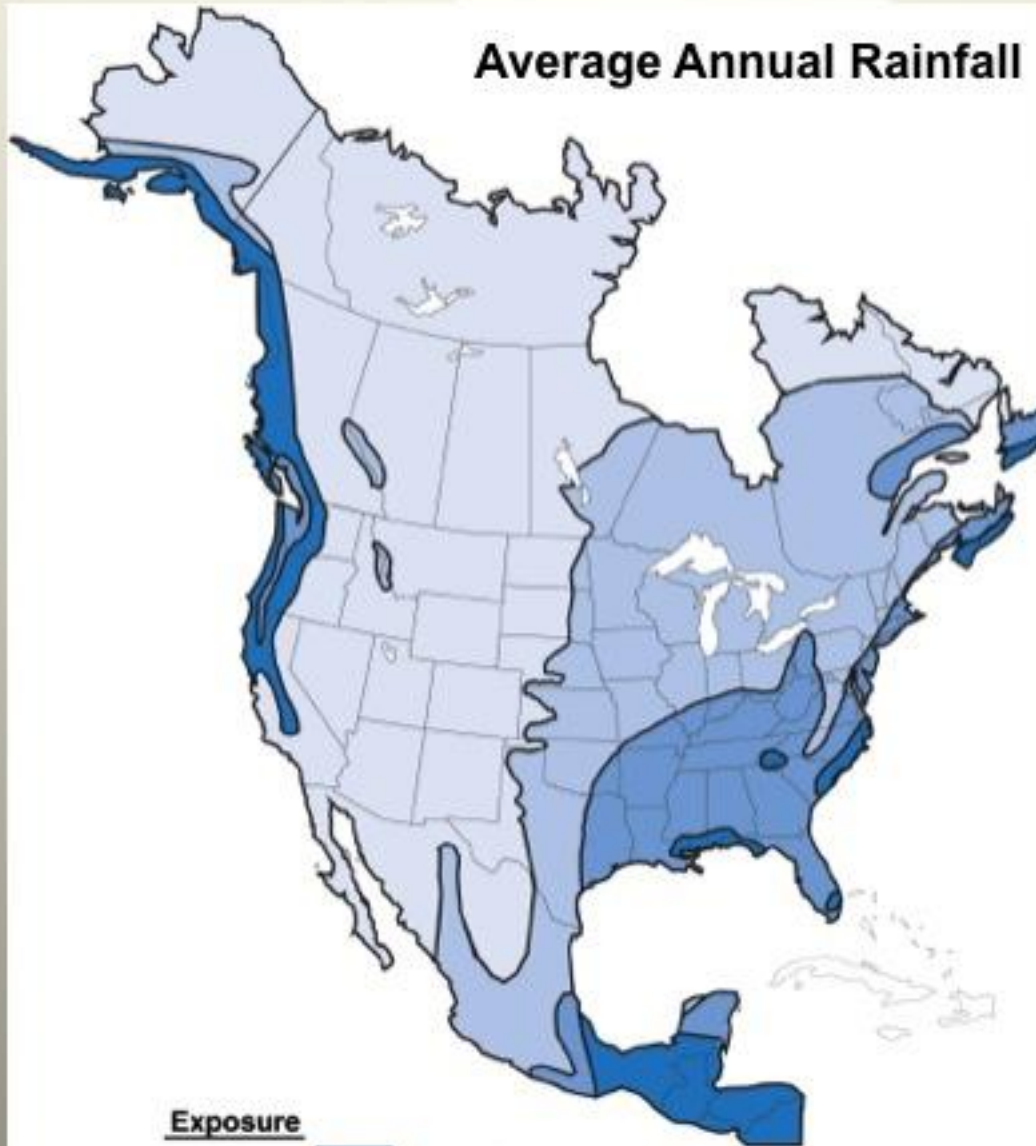
- Thermal comfort zone:
 - 70 degrees F to 85 degrees F
 - 20% to 80% RH
- Actual surface temperatures in building vary

What planet is this and why am I here?





- Dr. Who



Average Annual Rainfall



Exposure

Extreme		Over 60"
High		40" - 60"
Moderate		20" - 40"
Low		Under 20"

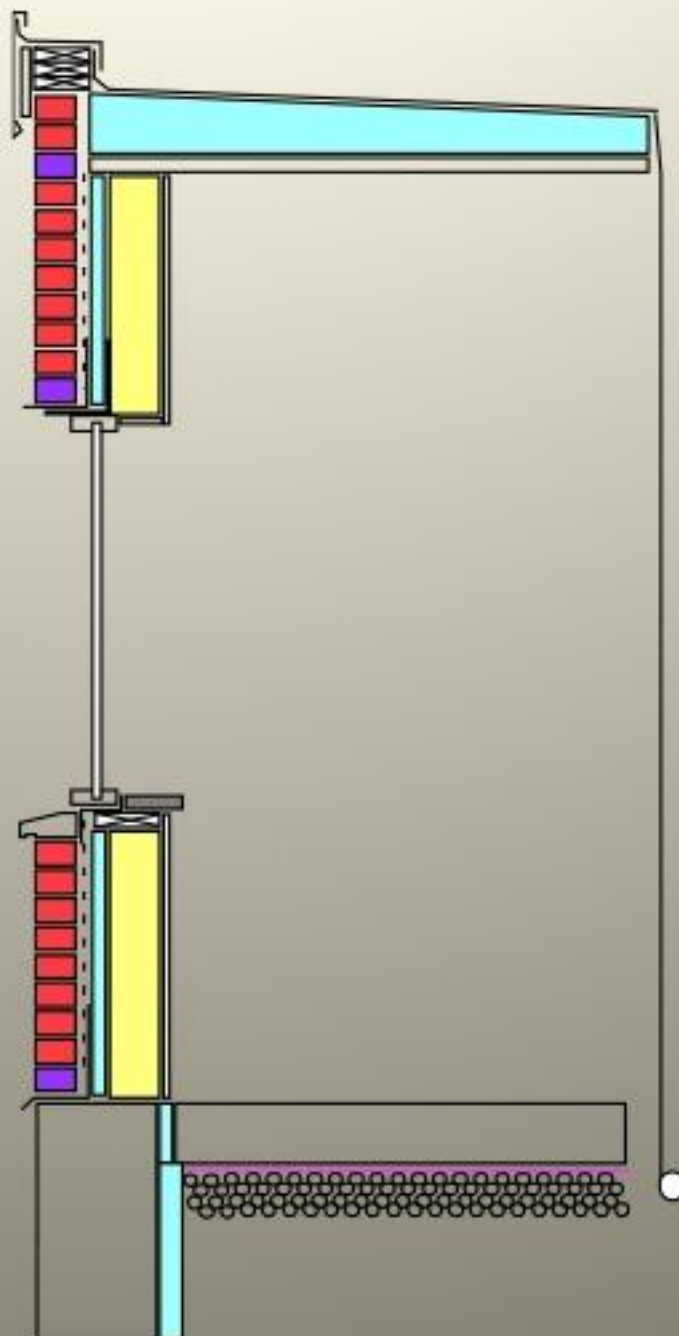
Source: Lallburek, Joseph (2006)
"Water Management Guide"

To Avoid Problems the Enclosure Must:

- Manage the flow of rainwater/groundwater
- Manage the flow of air
- Manage the flow of heat (and sunlight)
- Manage the flow of water vapor
- Manage the migration of creatures

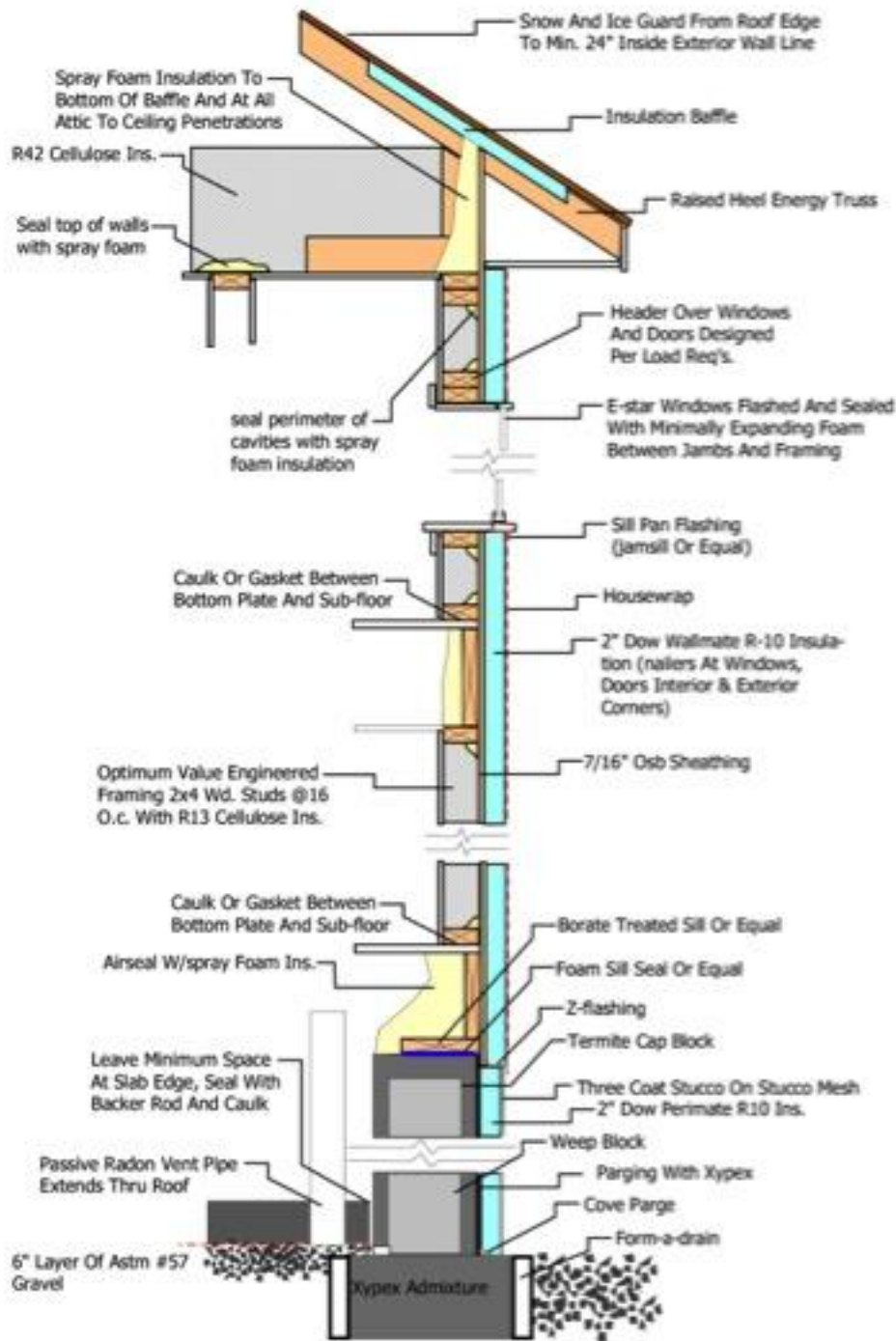
The Enclosure

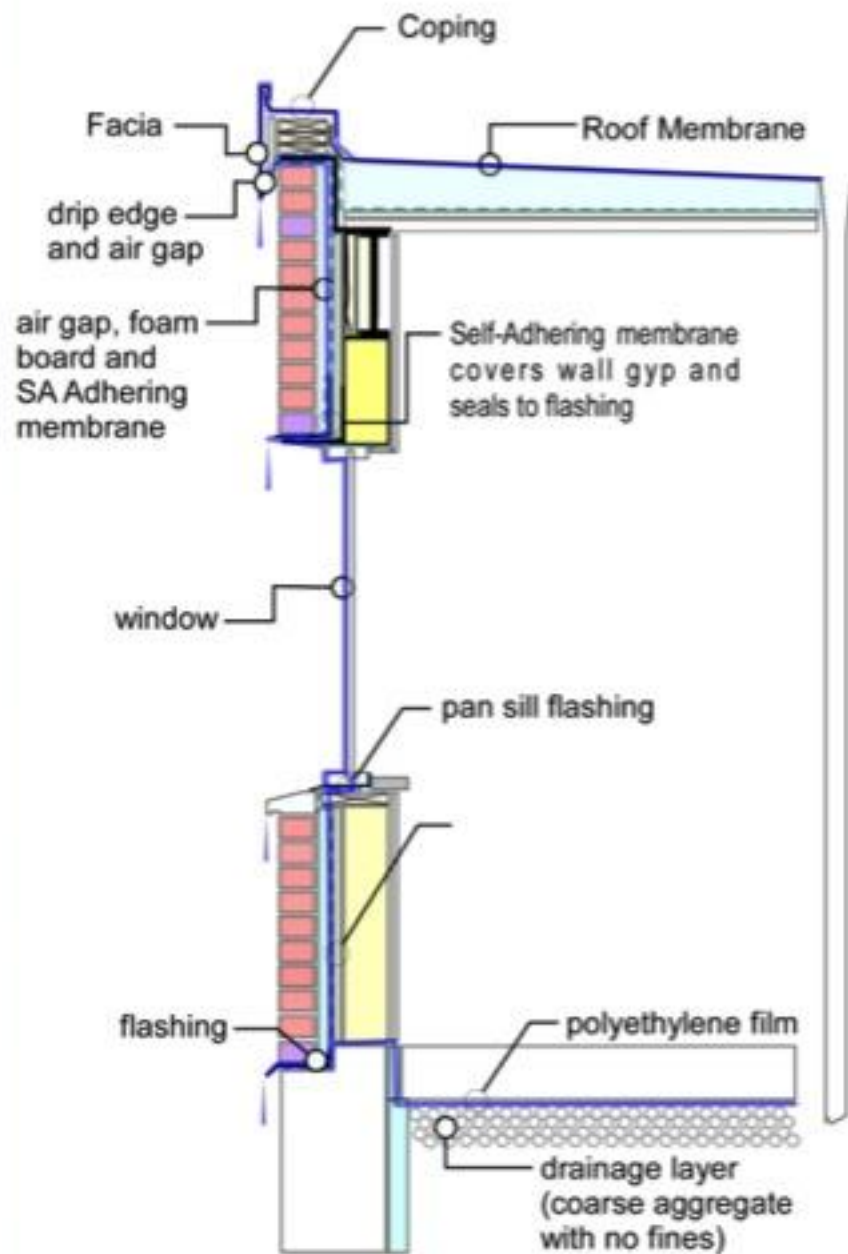
Continuity Test for
control of air, rainwater,
heat and water vapor



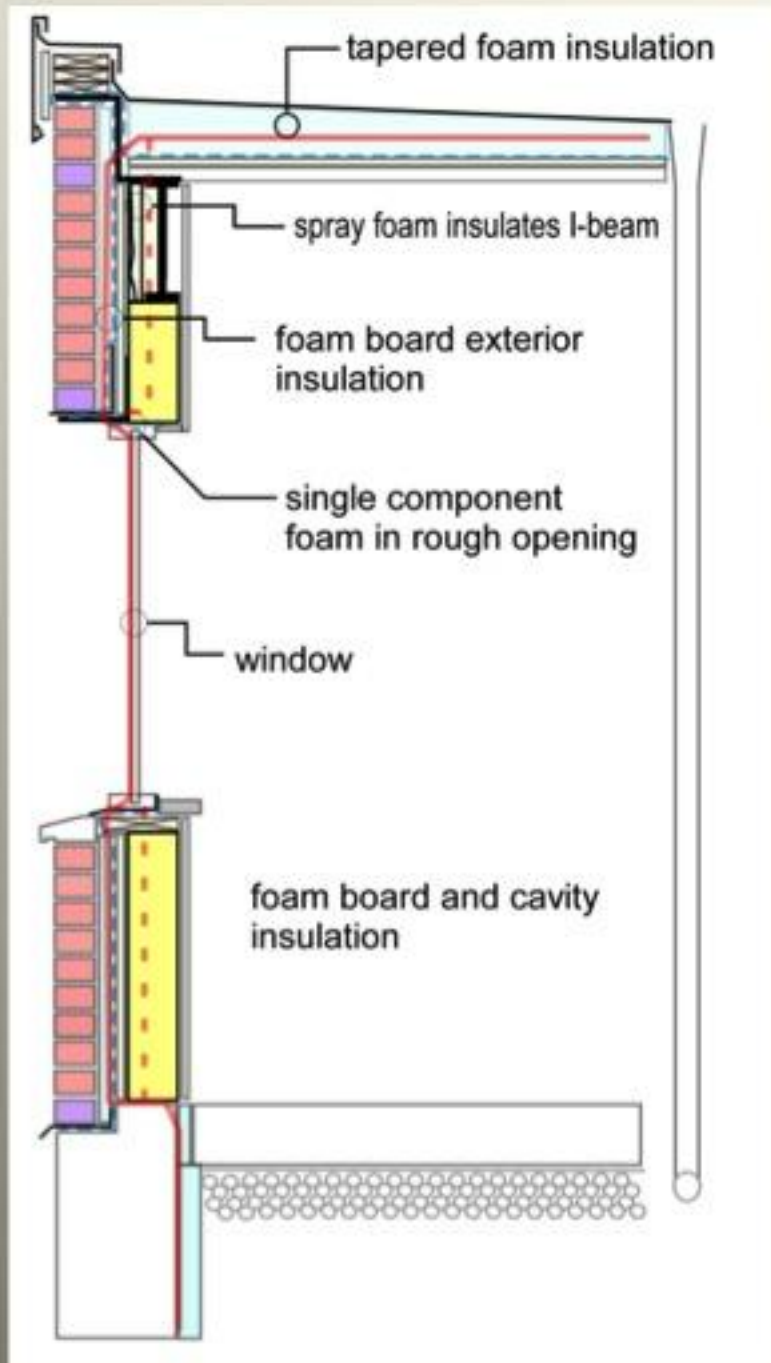
NYSERDA Homepic project house

Something you should know:
The crappy stuff works better than
you'd think and the good stuff
doesn't work as well as you'd think



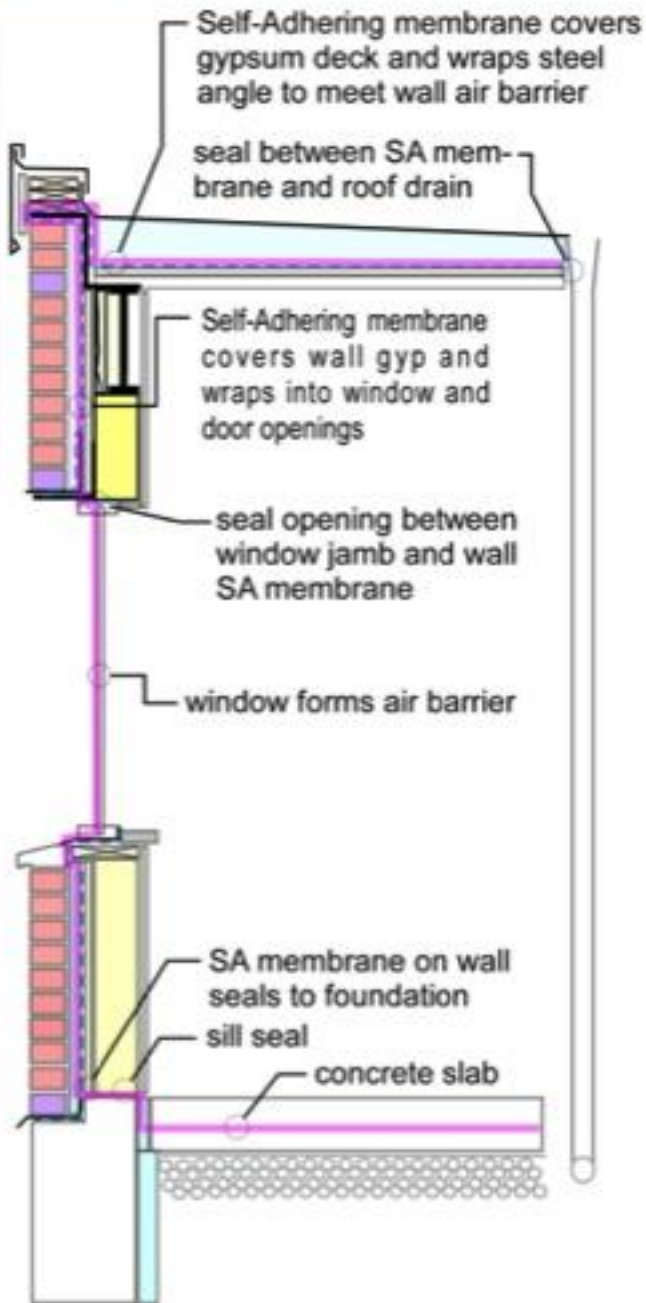


Tracing rainwater control from the center of the roof to the center of the foundation



**Tracing continuity
of thermal control
from the center of
the roof to the
bottom of the
foundation.**

Tracing continuity of air flow control from the center of the roof to the center of the foundation floor.



FSEC Study on Unplanned Airflows in Florida

- ducts were 70 times leakier than SMACNA Standard (1.2CFM250/100sq.ft.duct)
- suspended ceilings were 10 times leakier than sheetrock
- Repair of unplanned airflow problems reduced cooling loads by 15% at an average cost of \$454/building

Avoiding Condensation in wall assemblies

- Make it airtight in all climates
- Put all the materials with low perm (perm less than 2) on one side or the other of cavity
- Make one of the low materials at least an inch foam board
- Winter humidity less than the average January temperature plus 6

Moisture Control in Buildings

Moisture Related Problems

- Pest colonization (if you build it they will come)
 - termites, ants, fungi, bacteria
 - wood, MDF, OSB, paper, adhesives, textiles, paints
- Physical /Chemical
 - Corrodes, swells, warps, peels, dissolves, gooey smelly mess (hydrolysis)
 - metal, wood, paints, flooring adhesives, paper gyp board, MDF, latex emulsions

Moisture Sources

- **Poorly managed rainwater/groundwater**
- **Plumbing leaks**
- **Condensation on surface**
- **Construction moisture**
- **Spilled, tracked, water vapor**

Top Ten Things to Do If You Want to grow mold

- Build below the 100 year flood level
- Drain the rain into the building (or a river runs through it)
- Put a vapor barrier on both sides of a wall (or roof) or on the cool side of a wall (or roof)
- Suck or blow hot humid air onto cold surfaces (no air barrier – big holes and no pressure control)
- Don't exhaust baths, dryers or range hood
- Oversize air conditioners
- Make it hard to inspect and clean cooling coils and ductwork down stream of coils
- Don't pressure test the plumbing and put it where you can't tell when it leaks
- Paint, cover or enclose really wet porous stuff
- Use really good mold food in places that are gonna get wet

Preventing and Fixing Moisture Problems

- Drainage/Capillary breaks
- Accessible tested plumbing/drains
- Manage water vapor
 - Exhaust vent sources
 - Layer envelope/warm surfaces
 - Manage airflows (airtightness/dilution ventilation)
 - Dehumidify
- Dry newly installed wet materials
- Use moisture and mold resistant materials in locations that will get wet

Holistic Design Team



- Owner
- Architects, engineers
- Construction management
- Commissioning agent
- Builders, subs
- Buildings and grounds?

Design for Moisture Control

- How important is moisture control to the owner, to you?
- Provide moisture control detail in construction documents:
 - Building
 - During construction
 - O&M
 - Verification, testing and remedies

EPA Moisture Control Guidance

Indoor Environments Division
U.S. EPA



Moisture Control in Public and Commercial Buildings:

**Guidance for Design and
Building Professionals**

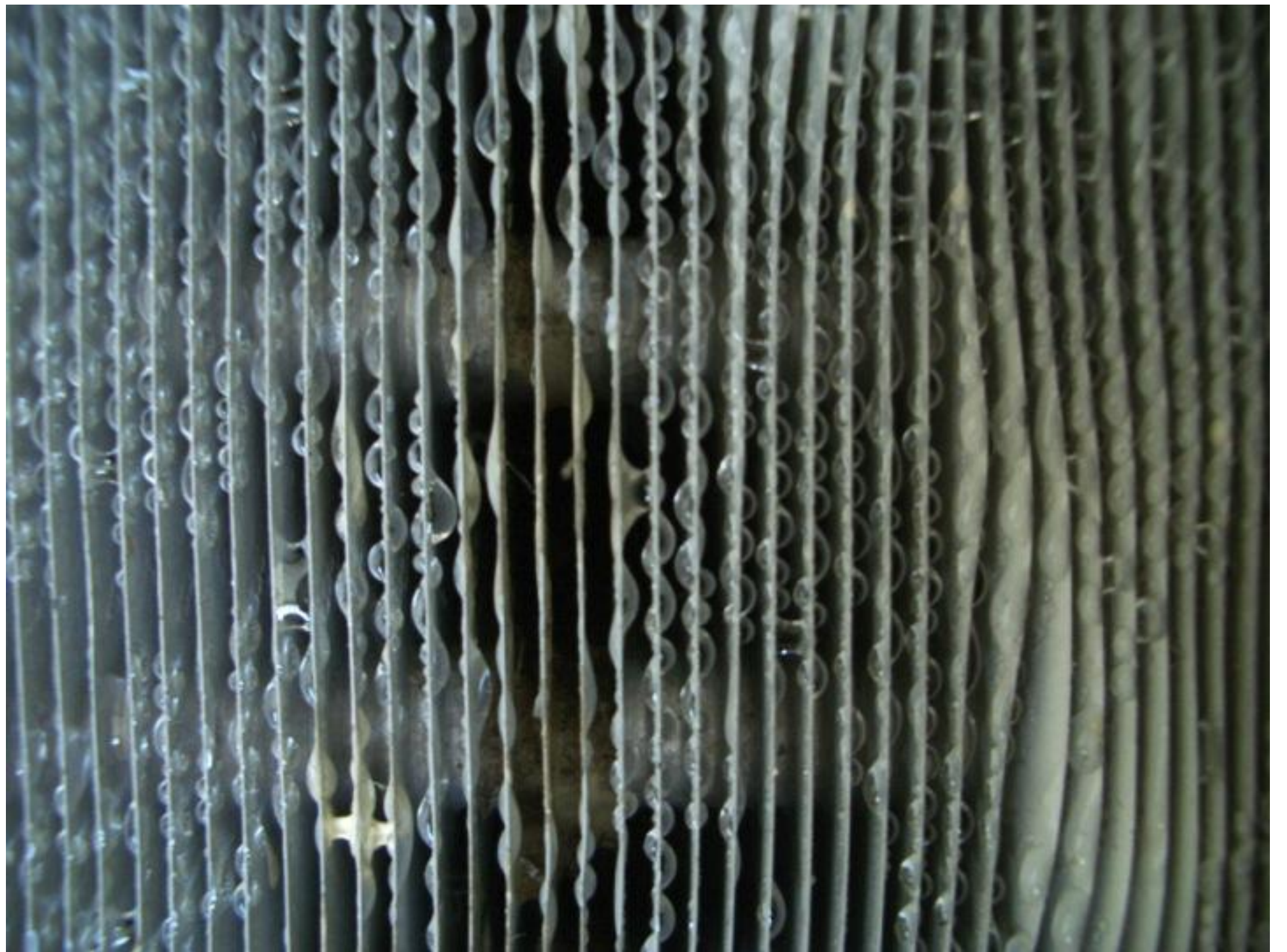
INTERNAL EPA REVIEW DRAFT

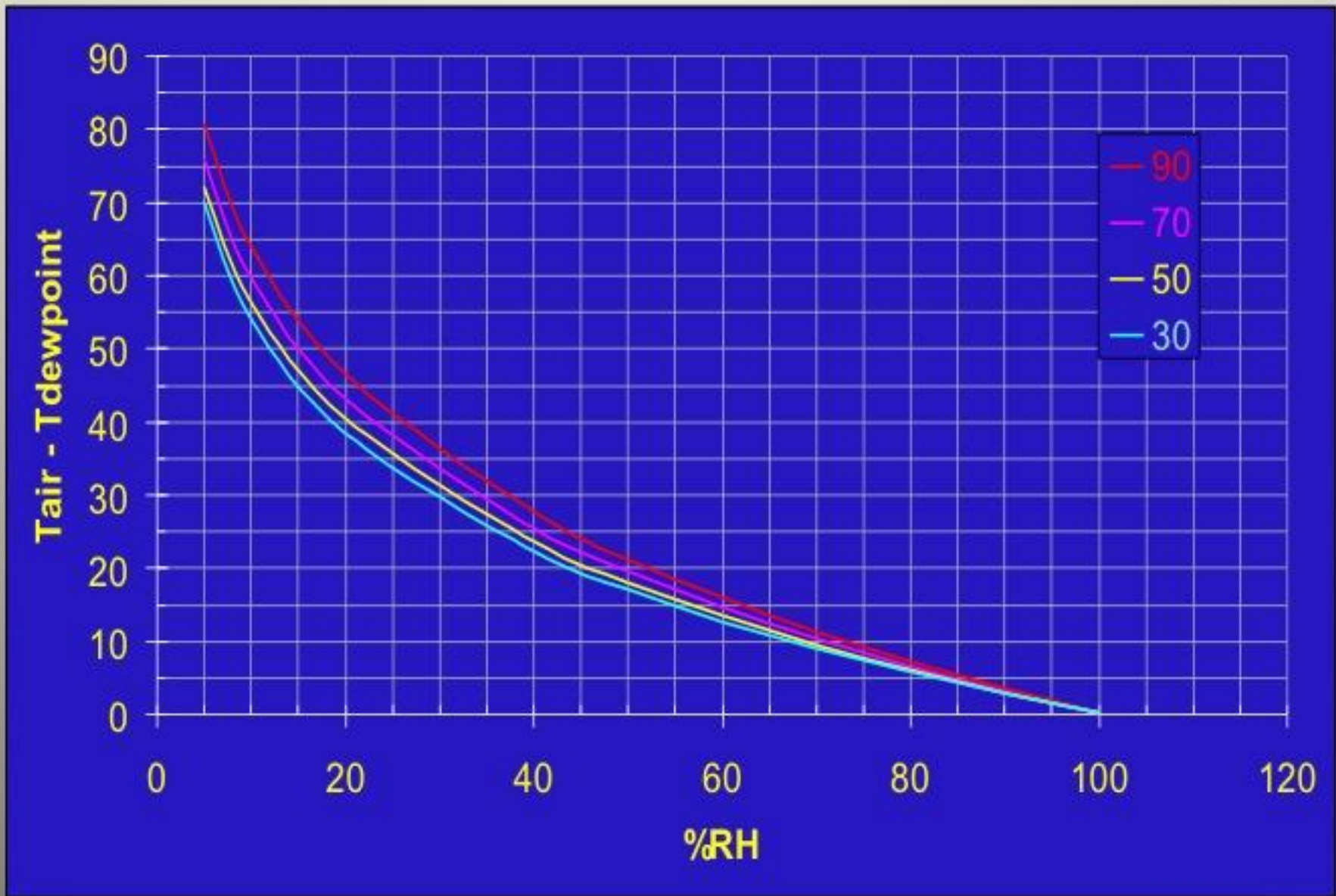
The Contents

1. Moisture Control Principles
 - Control Water Intrusion
 - Control Humidity
2. Design for Moisture Control
 - Storm Water Management
 - Enclosure Design
 - Mechanical & Plumbing System Design
3. Moisture Control during Construction
4. Moisture Control during O&M
5. Tools

Consider water



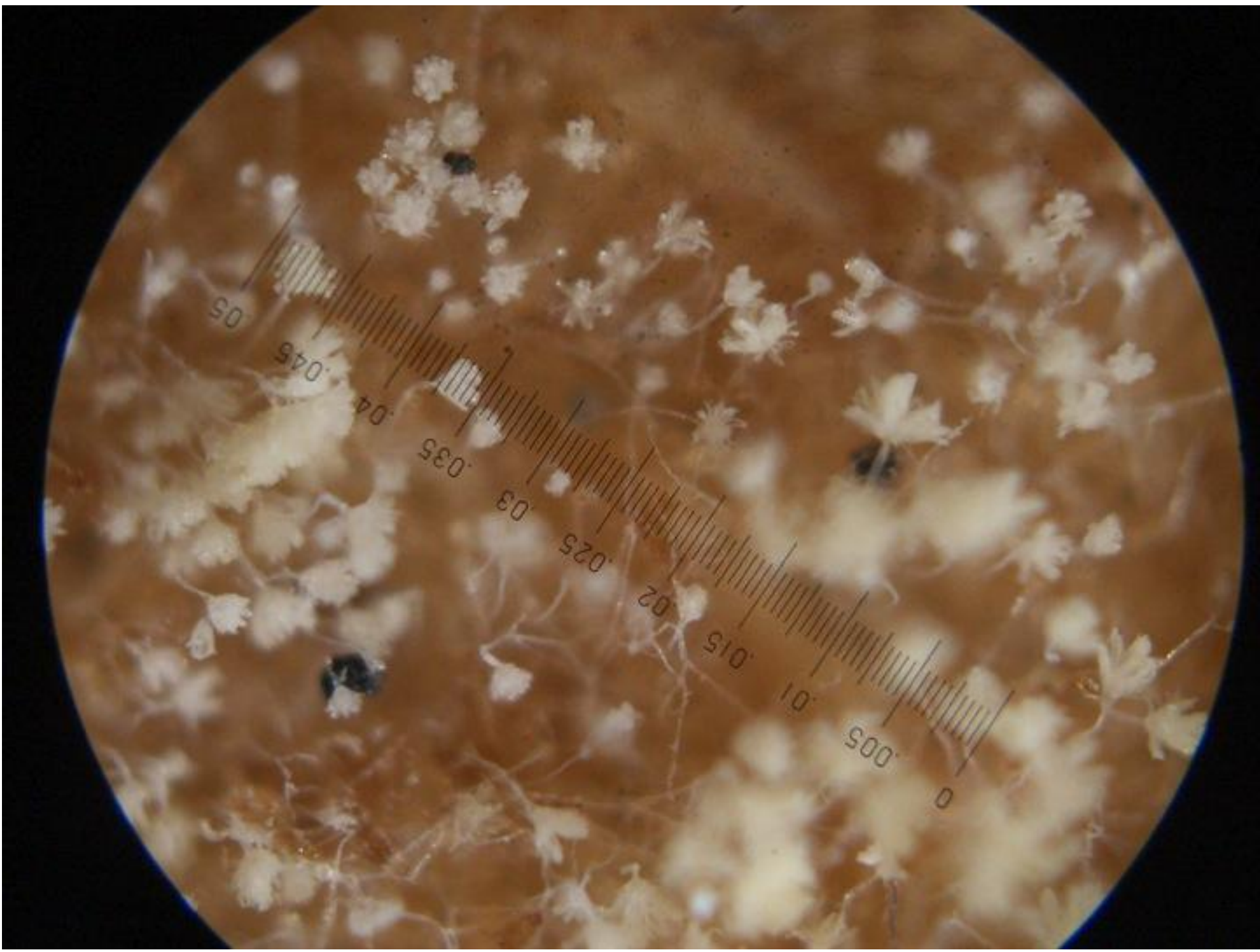




Some materials can tolerate:

- Soaking, sopping wet dampness for a long time with no problems
- Periodic superficial wetting as long as they dry quickly enough
- Any wetting what-so-ever







Pick the right site





**Engineering solution
for picking a poor
site**

Drain the site...



...into the building?

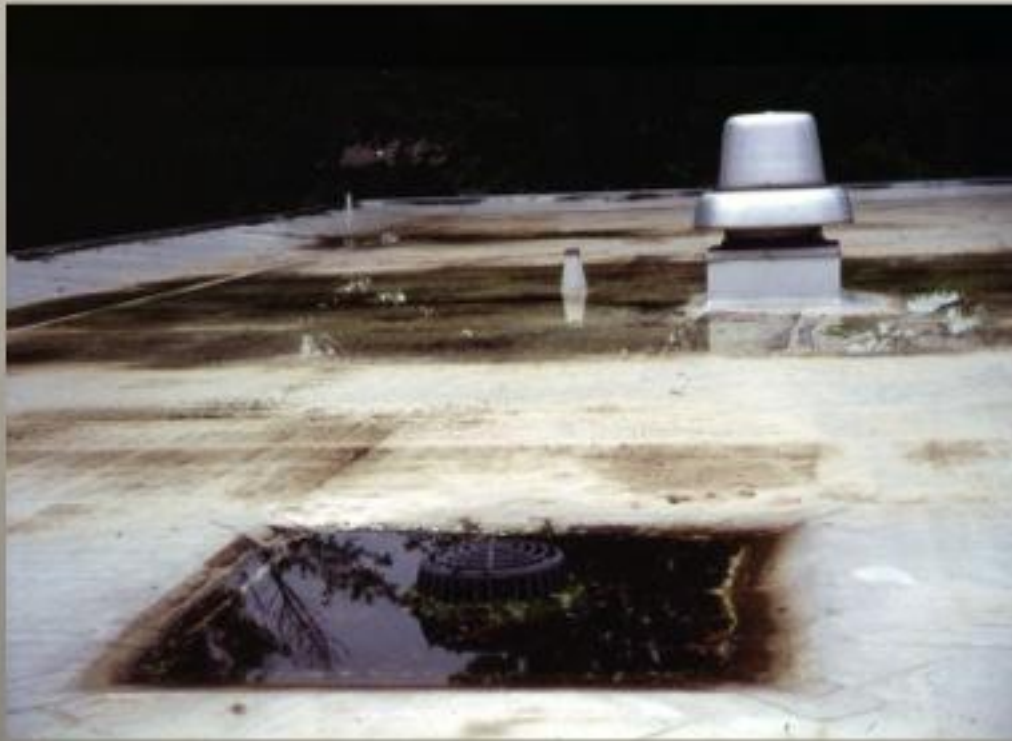


...what the @#\$\$%?



Drain the rain...

From roofs



**Most roof leaks are at
the penetrations and
edges**





**Cheap but
effective rain
protection
for parapet**




**Expensive, but ineffective
moisture protection for parapets**





From walls





**Where roofs
run into walls**

**Retrofit through wall
flashing - \$150 - \$400/
foot**



Drain the walls and windows









Workmanship is important





**Wind driven rain
leaks through
windows and rusts
bolts holding on
concrete panels**





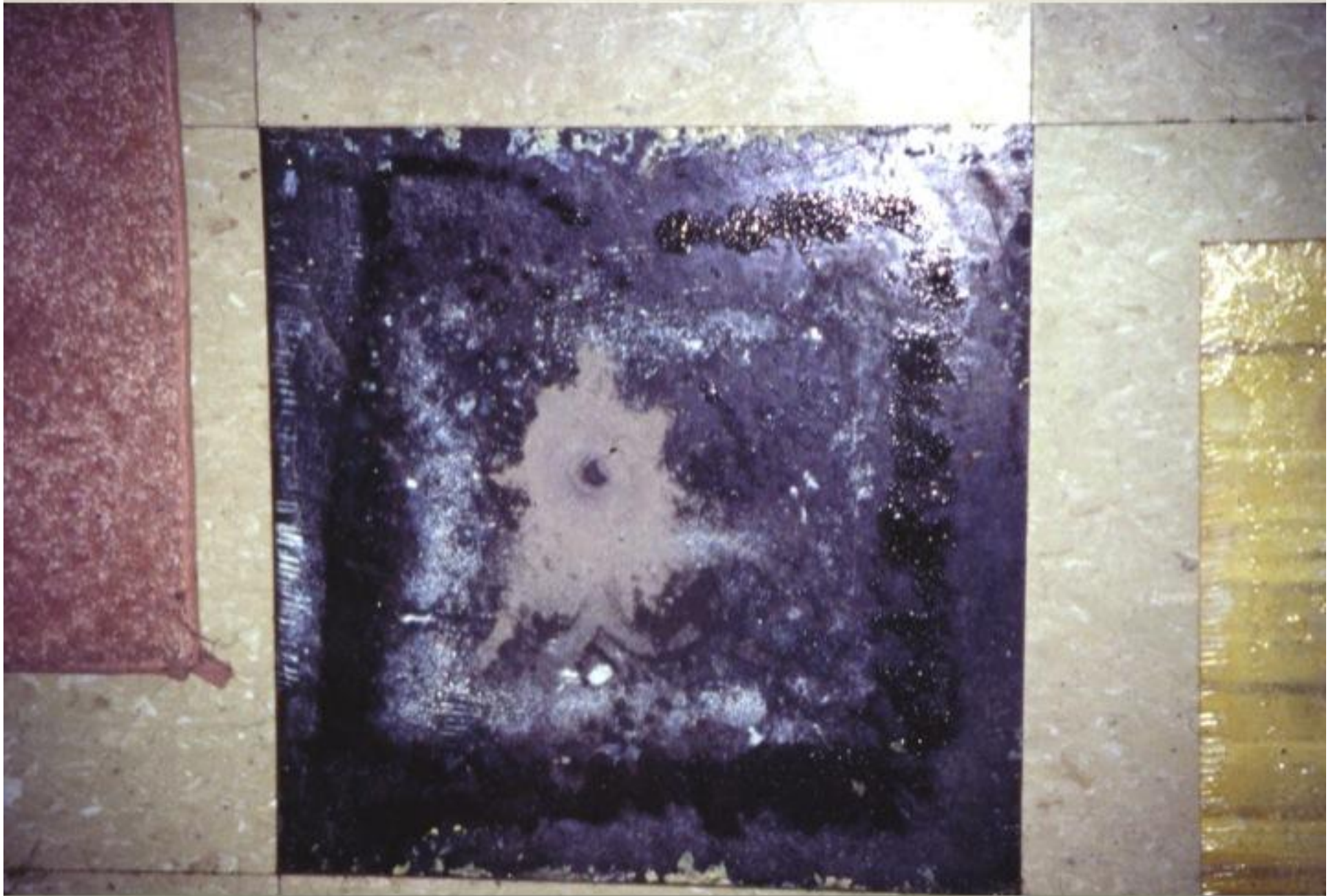
**The old way – carved
stone pan flashing**

Sill flash windows



Foundations







This third century Roman ceramic tile floor has lasted for nearly 2000 years.





No ducts under slabs (on or below grade)





Basement Rules

- Drainage and capillary break
- No paper or wooden products touch foundation materials
- Keep warm summer air from contact with earth chilled surfaces using foam insulation
- Put a drain in the floor



Capillary suction wicks water through porous materials.





Capillary Break

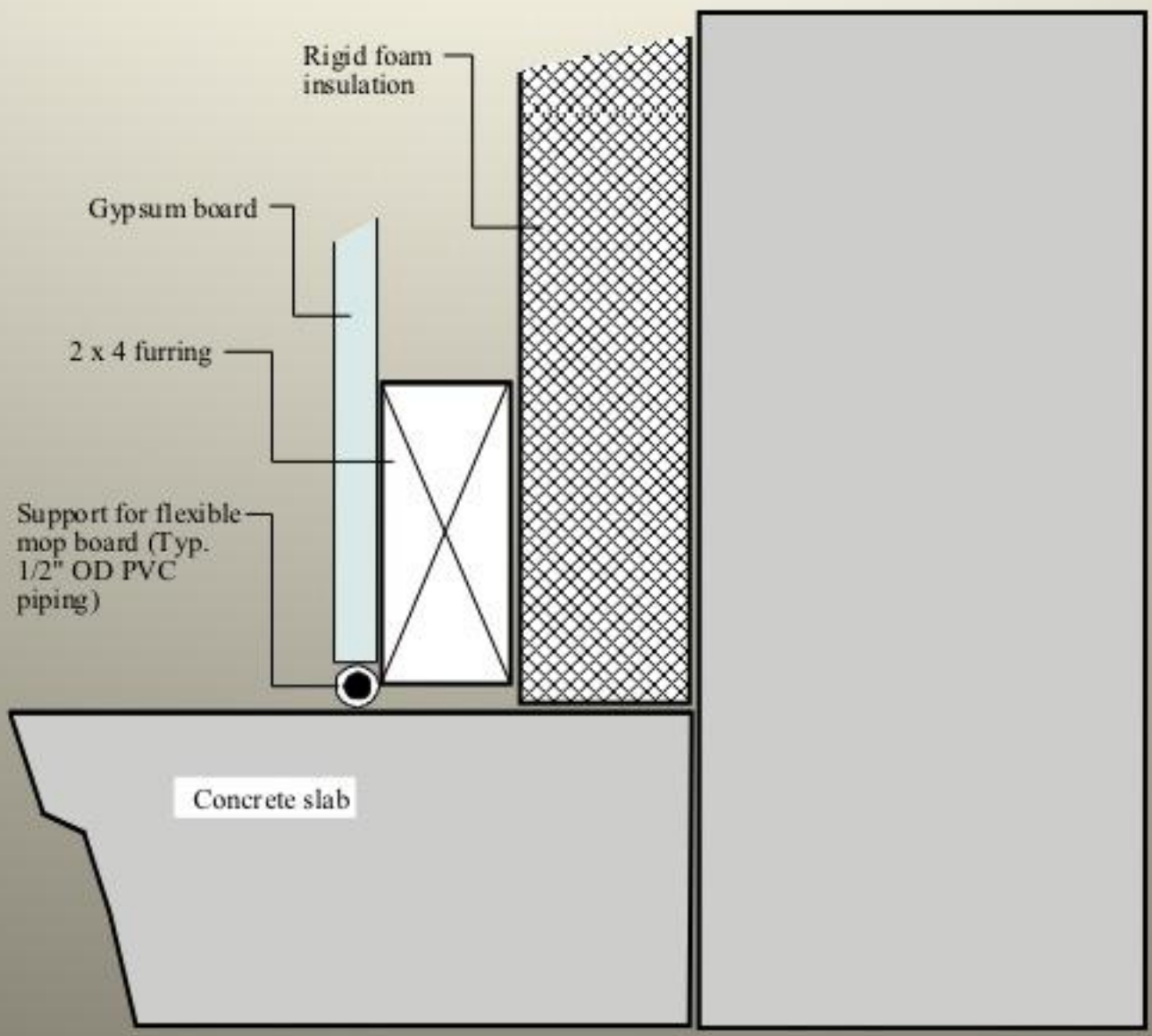


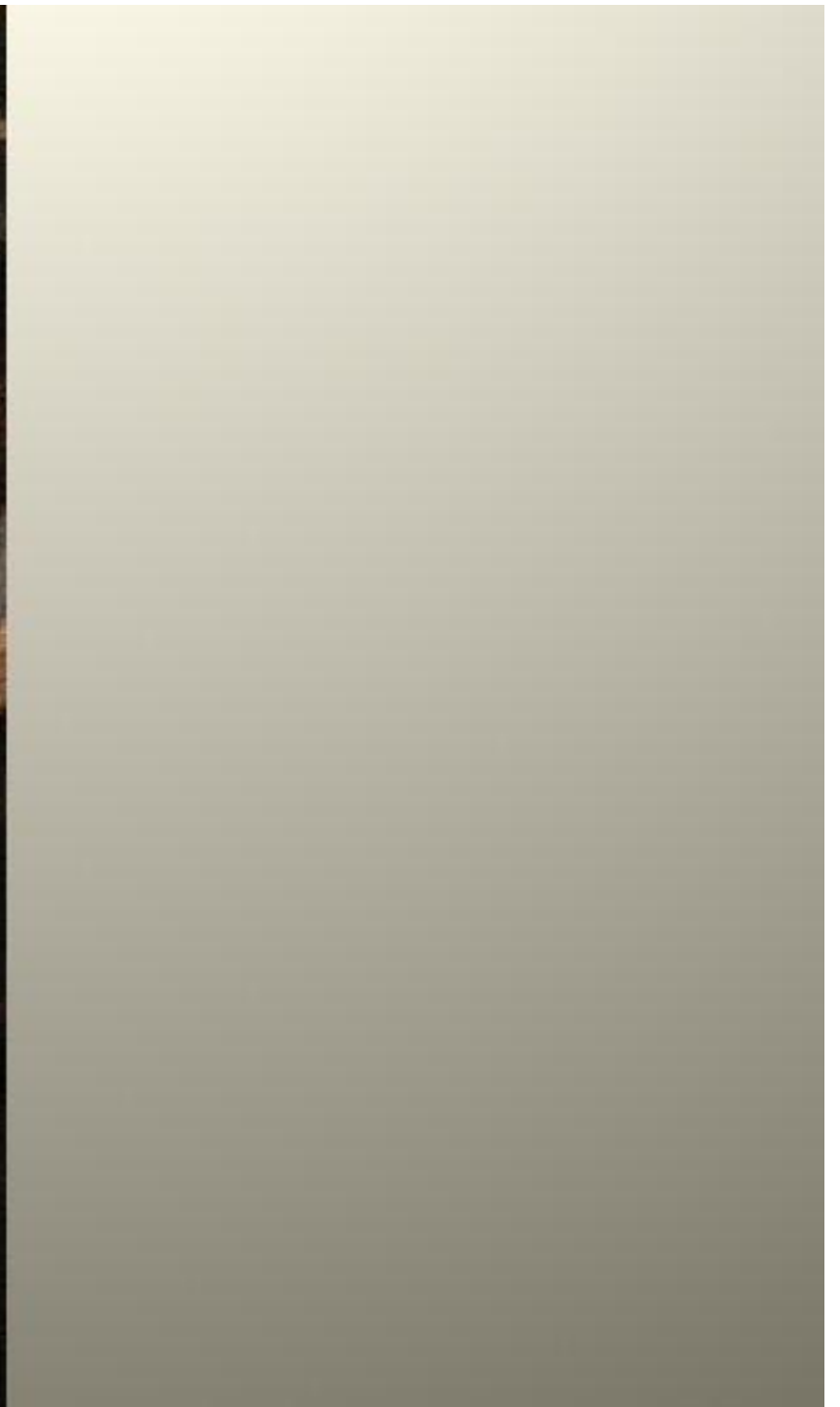




Foam board keeps warm, humid summer air from cold concrete – prevents condensation











Crawlspace guidance

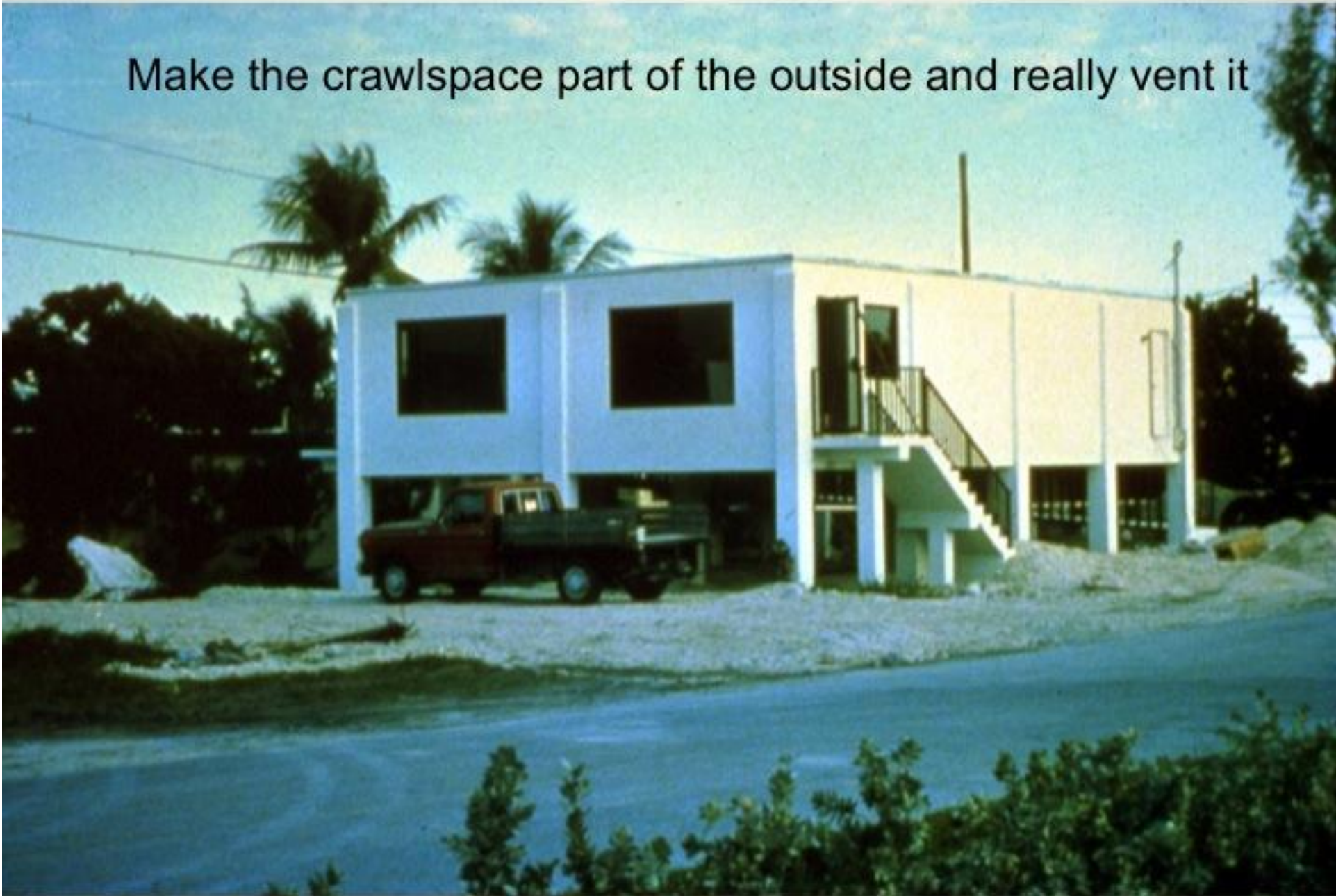
Make the crawlspace part of the inside

- Keep water out
 - use perimeter drainage to keep out rainwater and ground water
 - use a vapor barrier to prevent water vapor entry from the soil
 - repair plumbing leaks
- If crawlspace is dry - seal vents
- In cold climates insulate the crawlspace walls
- Exhaust air from beneath groundcover to prevent entry of soil air laden with radon or other contaminants





Make the crawlspace part of the outside and really vent it





And don't spray the building...









Plumbing

- No plumbing in insulated walls or ceilings
- Provide access to plumbing
- Test supplies, drains, appliances and fixtures

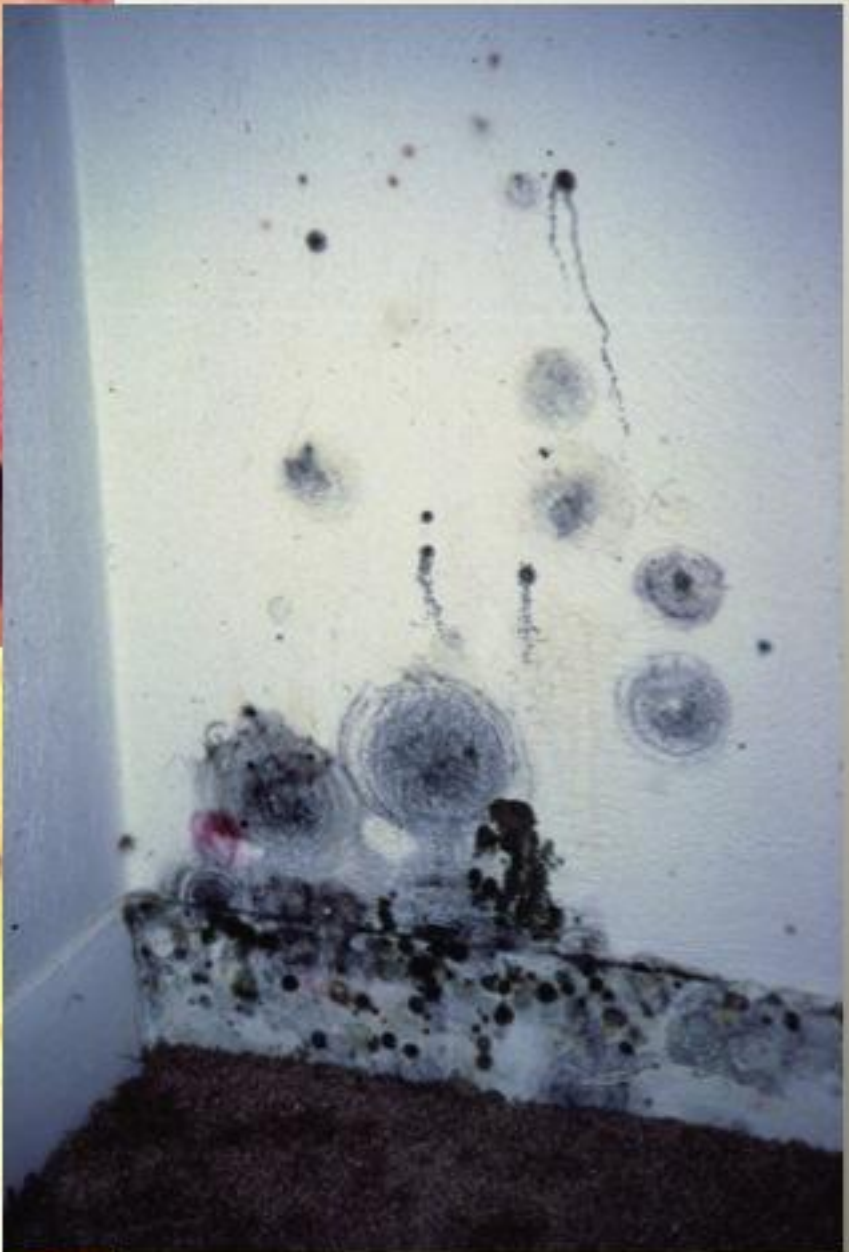


Condensation on cold water line insulation

**Condensation -
humidity and
chilled surfaces**

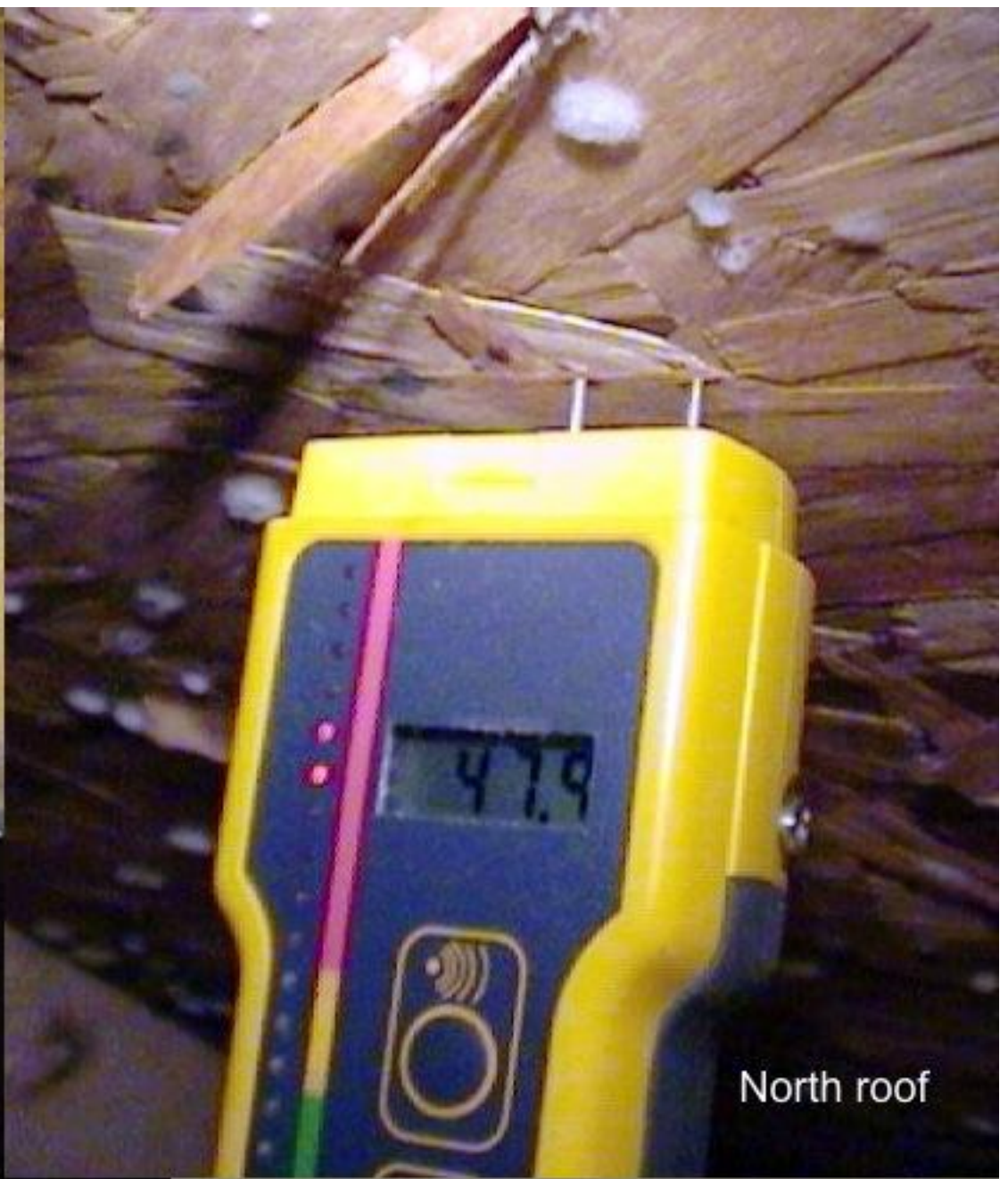








South roof



North roof

Humidified Buildings Cold Climates



Safe humidification?



**Condensation in
the enclosure
- cold outside**



