Florida Housing Coalition Hurricane Member Update Webinar

January 21, 2022
Sponsored by Fannie Mae

AGENDA

- Announcements
- ‘Lesson Learned’ from Manufactured Housing

Training Announcement

Planning to Shelter in Place

January 26 at 10:00 am

Register at
https://attendee.gotowebinar.com/register/2632188372316368399

Training Announcement

Best SHIP Practices in Serving Special Needs and Homeless Households

February 9 at 10:00 am

Register at
https://attendee.gotowebinar.com/register/1331798169169181199

Fannie Mae

THE FLORIDA HOUSING COALITION

‘Lesson Learned’ from Manufactured Housing

FEATURING “THE CASE OF THE MOIST MELTING HOUSE”

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FSEC®

THE FLORIDA HOUSING COALITION

Moisture Problems in Manufactured Housing

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FSEC ENERGY RESEARCH CENTER

UNIVERSITY OF CENTRAL FLORIDA

JANUARY 21, 2022

Moisture problems in manufactured housing

- Likely causes and contributors
- What they look like
- Lessons from the field
- Building science strategies

- Warning: Seek professional help to diagnose and mitigate mold problems.

Building Science Goals

- Occupant healthy and safety – prevent biological growth
- Building durable – prevent rot, rust, warping, etc
- Occupant comfortable – cool and dry
- Energy efficiency – reasonable utility bills

- **All affected by air, heat, and moisture movement**
- Movement into, out of, through, around, within, over, and under the conditioned space
- If there's a moisture problem, something somewhere is moving!

Moisture Problems in Manufactured homes Likely causes and contributors

- Area of high moisture concentration
  - Crawl space, attic, outside air
- Driving forces
  - Depressurization (suction, pulling)
  - Caused by duct leakage, exhaust fans, bedroom door closure, inadequate return air paths
  - Pressurization (pushing)
- Path

Moisture Problems in Manufactured homes Likely causes and contributors

- Source, driving force, and a path

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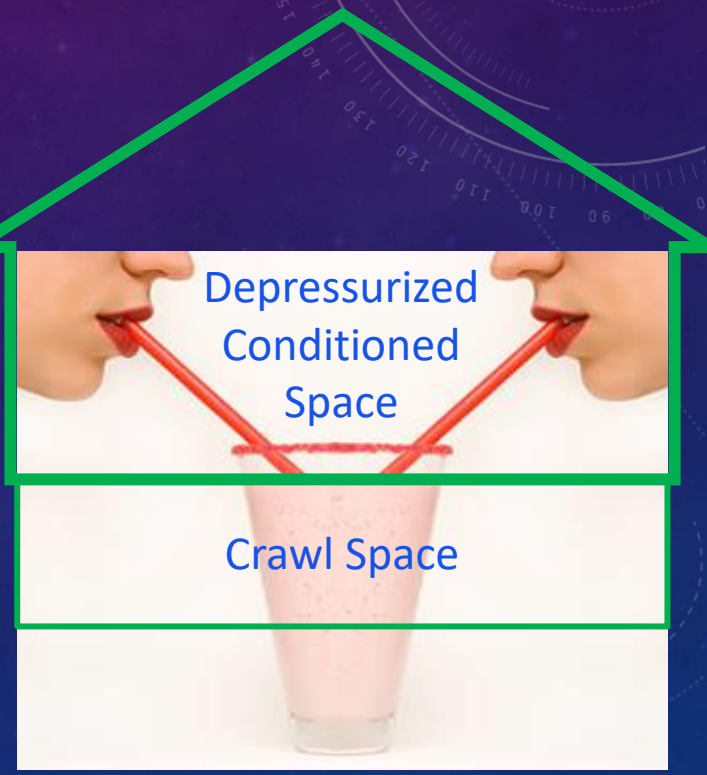


Moisture Problems in Manufactured homes Likely causes and contributors

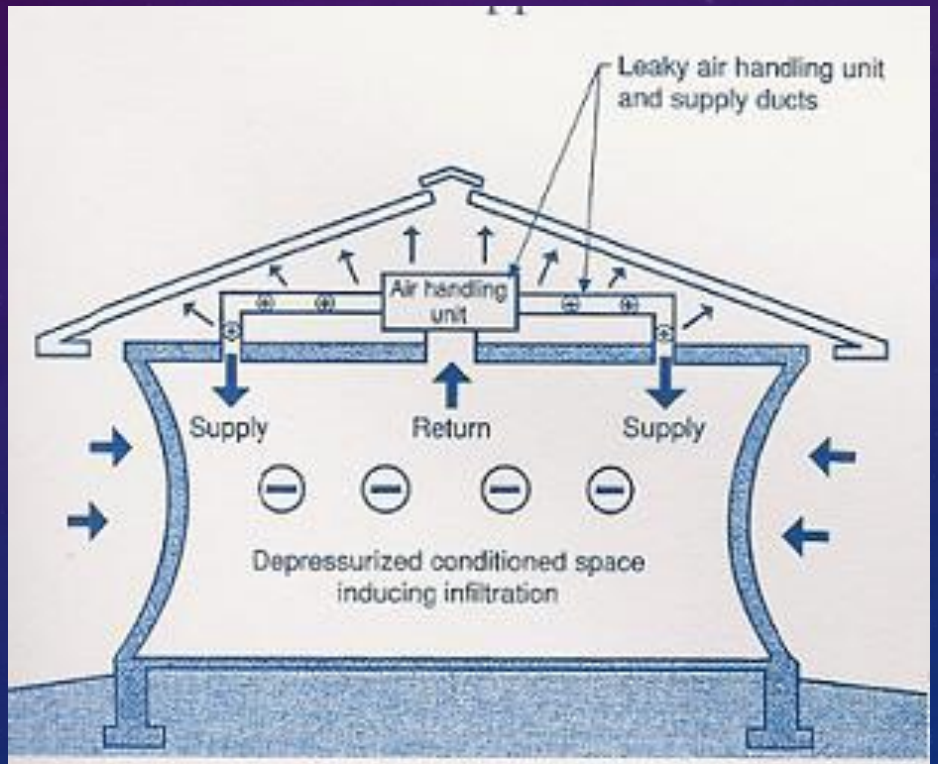
- Today's examples
- Source: high humidity in the crawl space
- Driving force: depressurization of house
  - Duct leakage
  - Exhaust fans
  - Door closures

Causes of Duct Leaks

- Use of sealing materials which are not durable over time
- Improper application of sealing materials
- Building cavities used as a duct
- Lack of duct support

- Failure to isolate plenum cavities from adjoining building structure
- Exposure to UV
- Rodent/human damage
- Poor design (diapered ducts
- Workmanship

Moisture Problems in Manufactured homes Likely causes and contributors: duct leakage depressurizes conditioned space

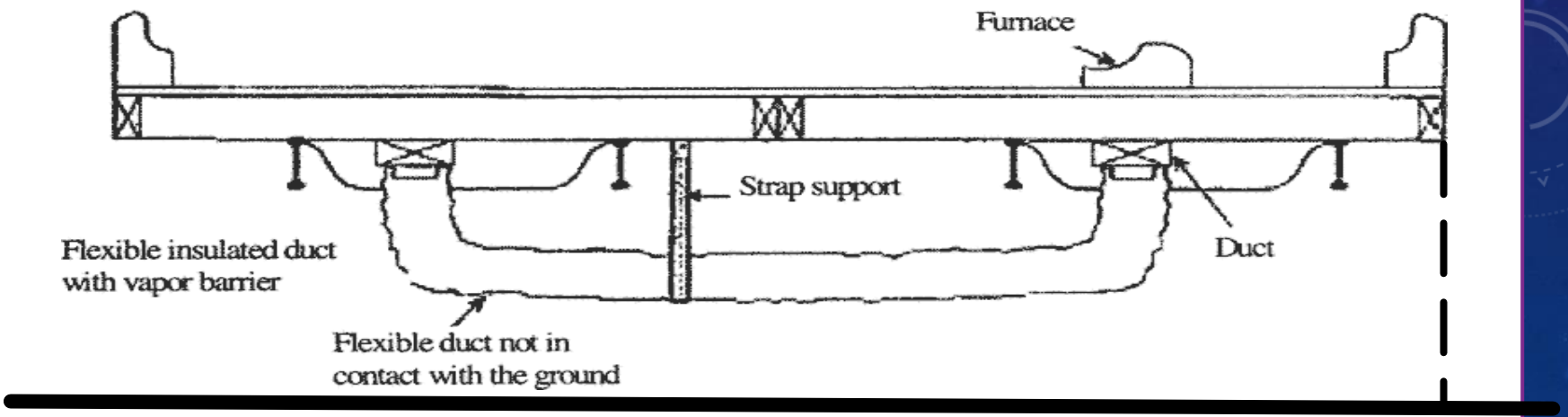


Negative Pressure Caused by Leaky Ducts

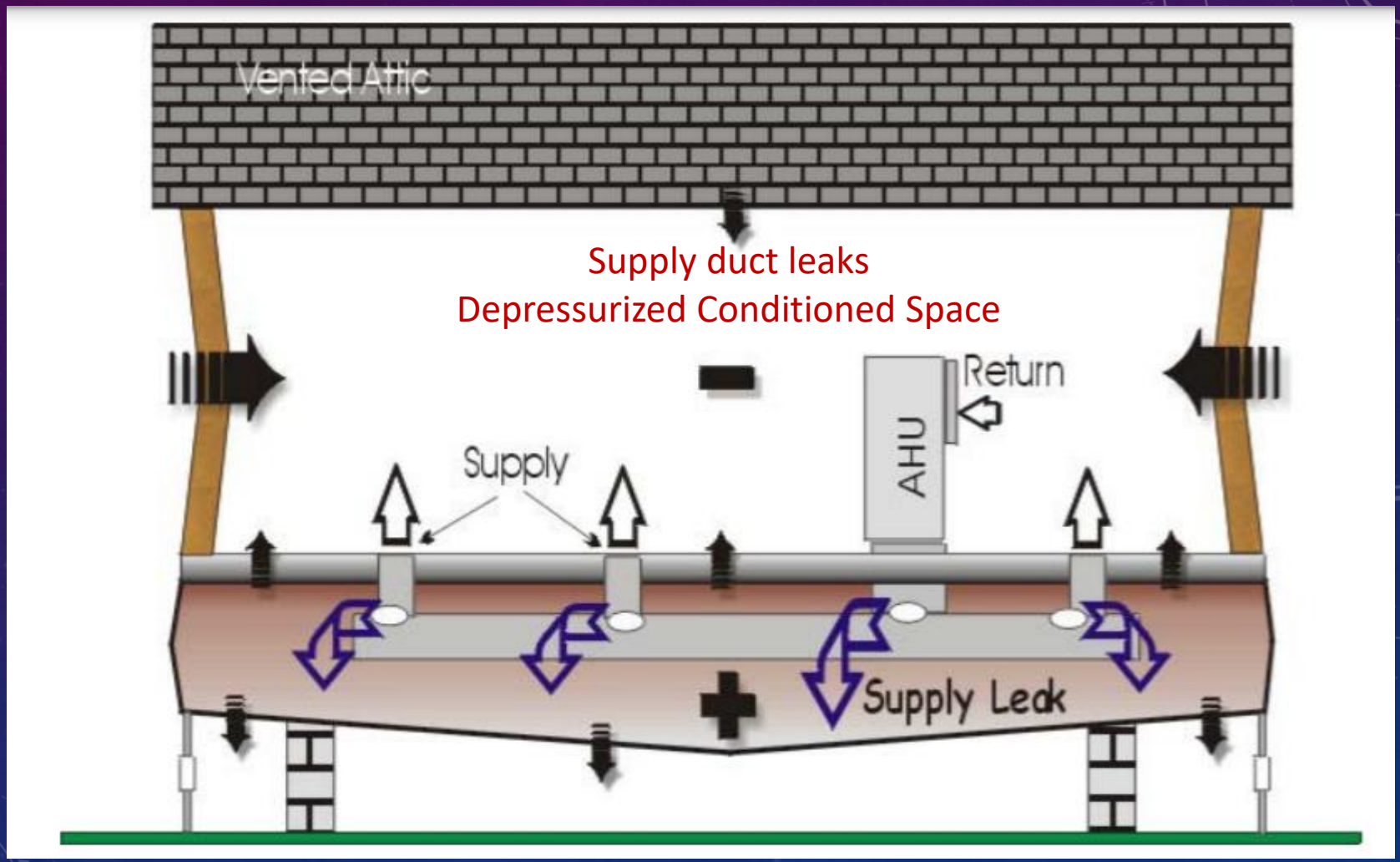
Moisture Problems in Manufactured homes Likely causes and contributors

- Duct work and the crawl space
- Cross over ducts, overhead ducts, floor ducts, supply and return ducts to package units, mysterious abandoned ducts, disconnected ducts

Figure B to §3285.606 Crossover Duct Installation with One Connecting Duct.



Moisture Problems in Manufactured homes
Likely causes and contributors. Why ducts?!



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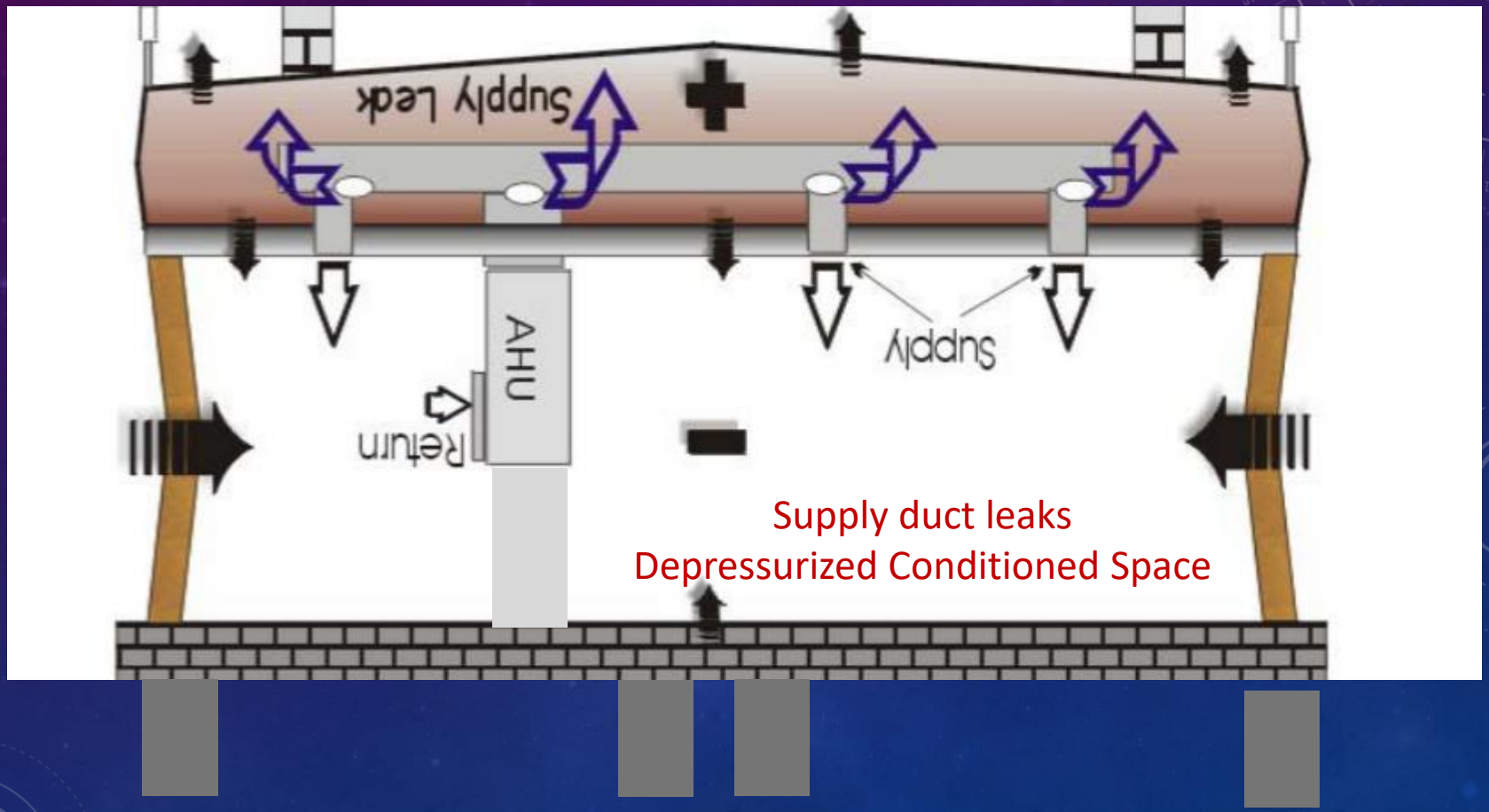


Moisture Problems in Manufactured homes
Likely causes and contributors. Why crawl spaces?!

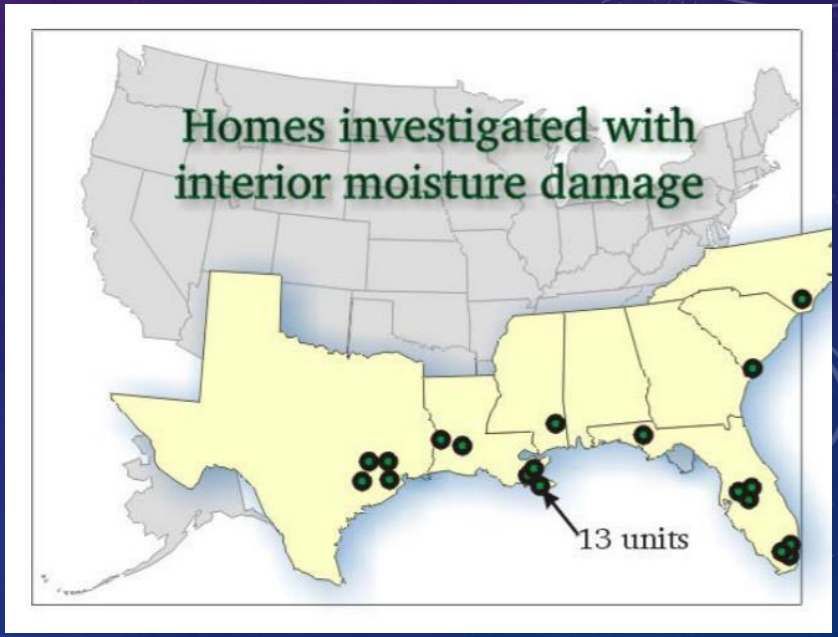
- No tears in belly board
- Ground cover extends to edges
- No standing water
- No evidence of flowing water
- No growth
- No exposed ductwork

Moisture Problems in Manufactured homes
Likely causes and contributors. Why crawl spaces?!

- **House ends and water begins**
- Standing water
- Flowing water
- Enclosed humid air
- Duct leakage – condensation

Moisture Problems in Manufactured homes What do they look like?

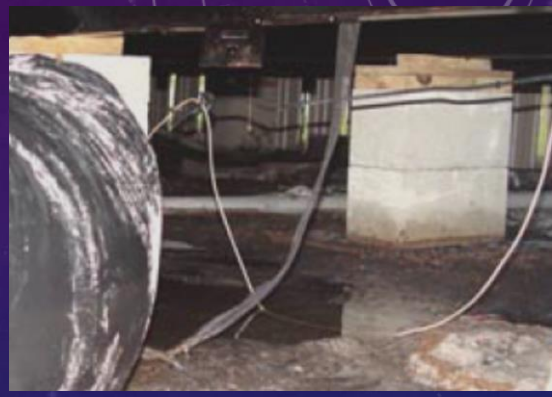
- About 25 houses
  - One or more repair attempts
  - No roof, wall, or plumbing leaks
  - No overflow events
  - No extraordinary sources of indoor moisture (e.g. fish tank)
- New homes



Moisture Problems in Manufactured homes
How do we find them?
Air tightness and air pressure testing

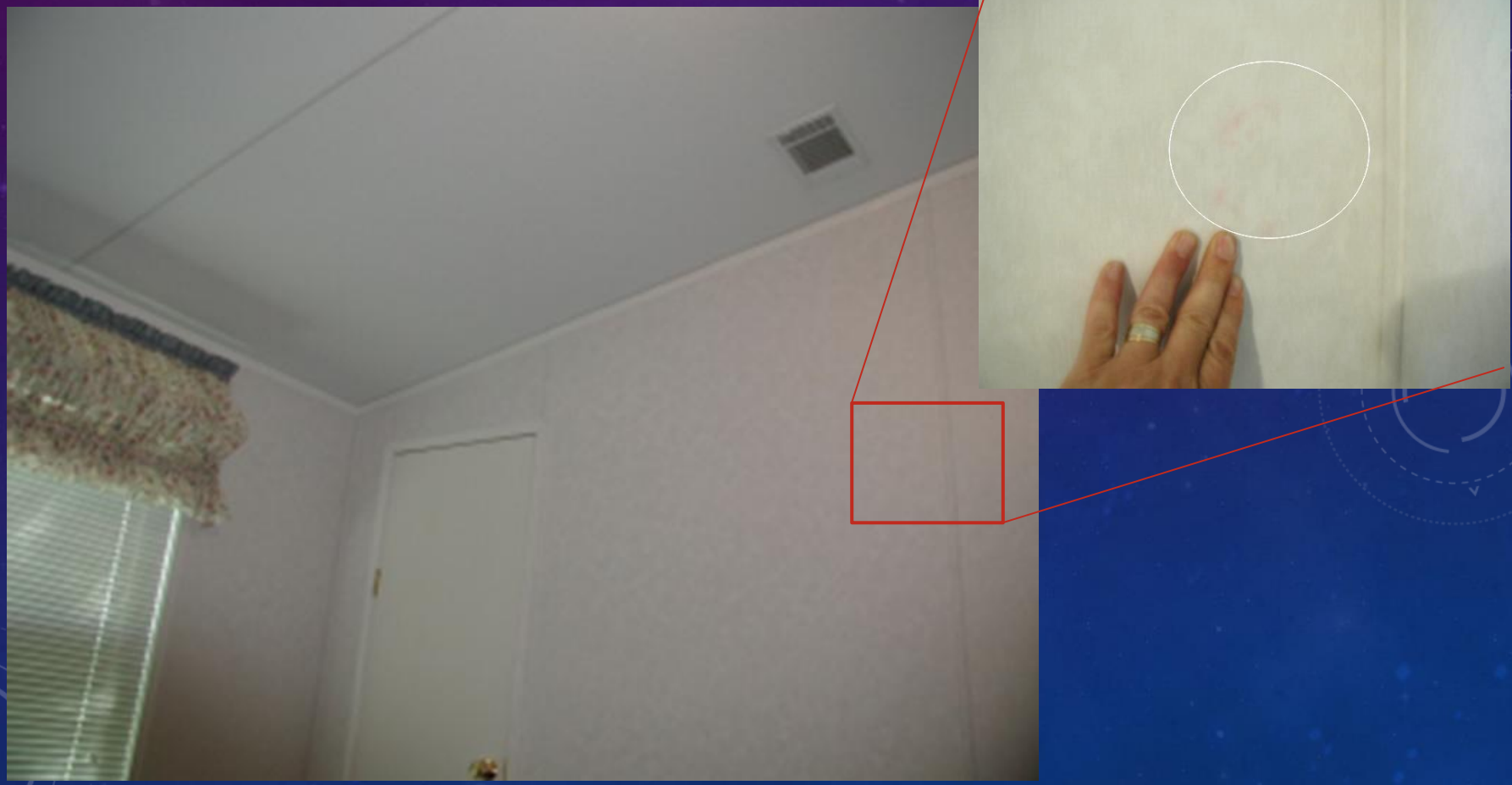
Blower door set up for an air leakage test.

Moisture Problems in Manufactured homes
What do they look like?



- Damage
- Rot
- Rust
- Discoloration
- High tide lines
- Biological growth
- Bulking, bulging, swelling, warping
- Dirt, mud, mushrooms, moss, bugs

Pink mold on wall paneling
High humidity, cold walls
Mold loves 60%+ relative humidity



Mold growth behind vinyl wall paper

- Room depressurized
  - Duct leakage, door closure
- Outdoor air/moisture pulled into wall assembly
- Can’t go through vinyl wall paper
- Viola! Very high surface humidity
- Mold loves wet paper!
- Do not disturb the mold
- Remove all molded materials

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Observe and document patterns and concentration

- Evenly distributed mold growth, indicates high humidity throughout space

- Concentration of mold indicates a point source and direction of moisture flow

Biological growth under vinyl flooring

Overhead supply register + holes in belly board
Crawl space air in contact with surface at dew point
High surface RH = mold growth

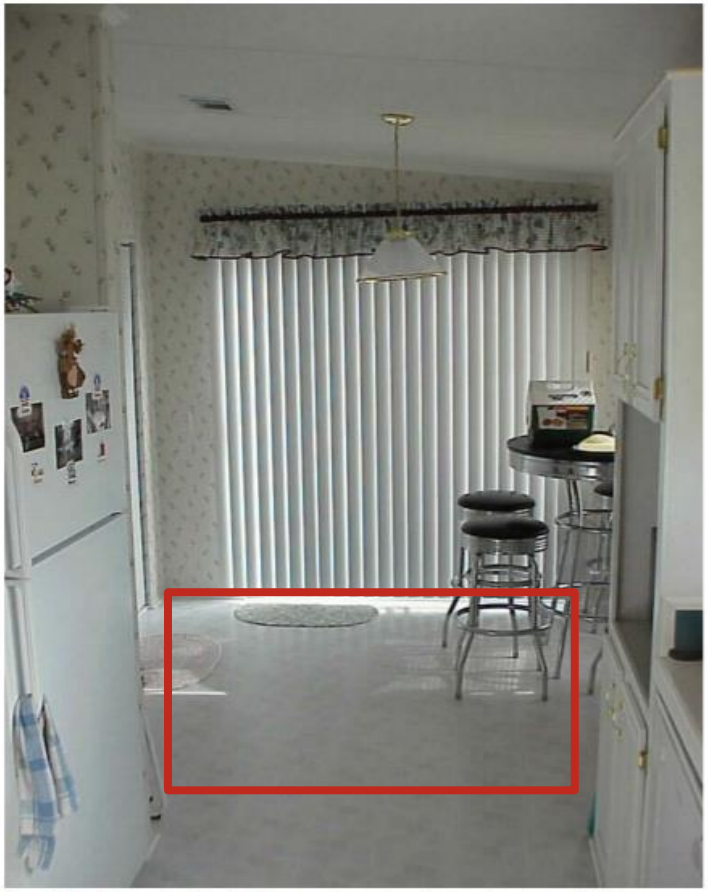


Figure 7 Breakfast nook with a vinyl floor covering and overhead supply register. Visible discoloration of the floor (pink spots) existed primarily in the area between the table and the cabinets on the right side of the picture. The supply register was oriented as to blow air to the outside wall.

Figure 8 The floor covering has been partial removed. The plywood flooring was wet to the touch and staining exists on much of the under side of the vinyl. The floor decking was removed to inspect the underside – it appeared dry.

Warped floors

- High RH in crawl space
- Depressurized house
- Moisture collects in sub floor, can’t go through the vinyl

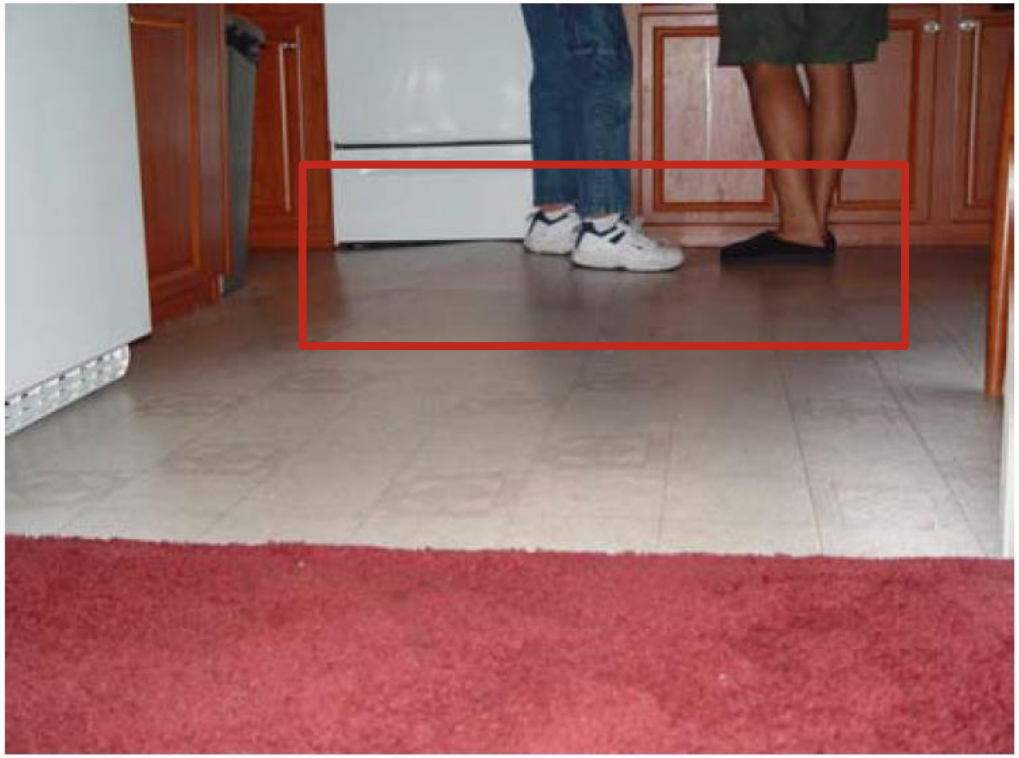


Figure 1. Warped floor

Warped floors

Warped floors
Moisture from crawl space absorbed by sub floor
Vinyl flooring stops moisture movement

Moisture damage at ceiling edge of marriage wall

- Missing gasket at outer edge of marriage wall
- House depressurized by duct leakage
- Pulling air in through unsealed edges of marriage wall.

Warped trim and staining in living room

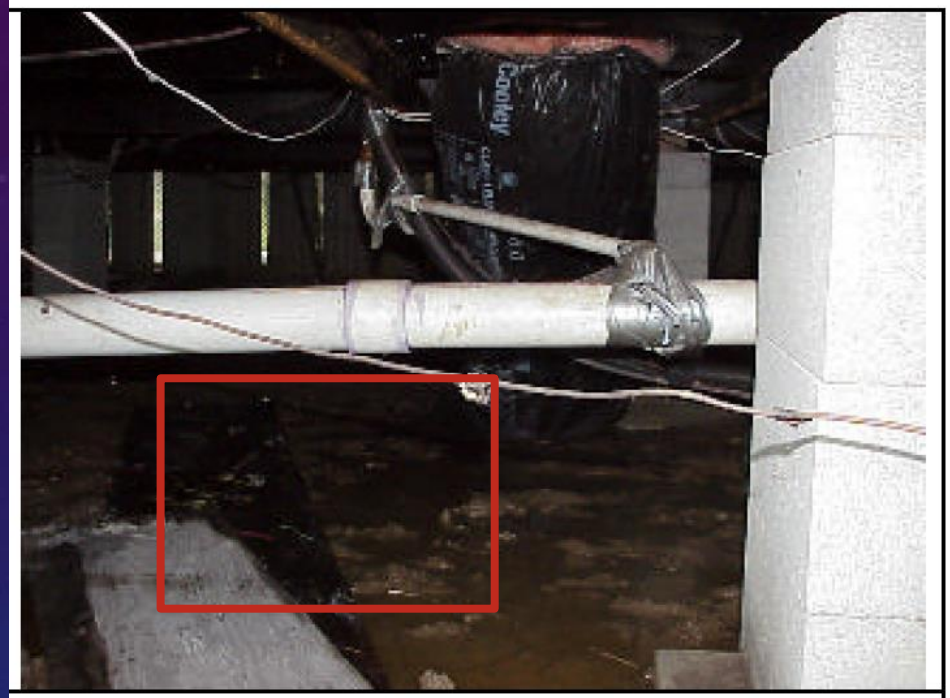
ures

+ missing gasket =

narriage wall, wall board bowed

Vegetation indicates ground water
High RH in crawls space increases risk of condensation, rust
Enticement for foraging critters

High Tide Lines
Standing and flowing water increases crawl space RH



The wet crawlspace and crossover duct

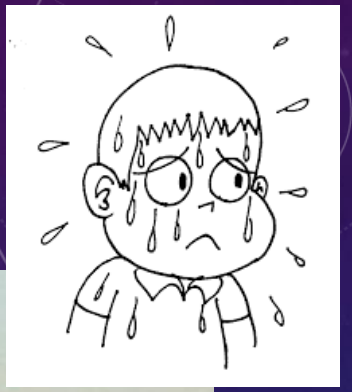
Figure 4. Flow lines under house, indicating running water under the house. Also note the "tide line" again.

Wet crawl spaces

- Increase risk of condensation, rot, rust.
- Standing water
- Direct site drainage away from house with gutters, gullies, ditches
- Fill low spots

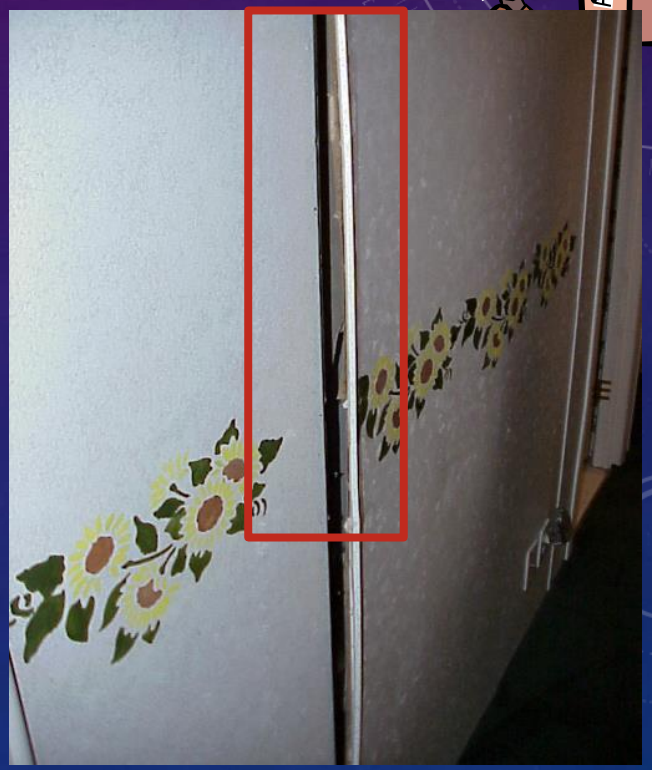
Figure 3. Standing water under house. Also note the duct work resting on the ground, absorbing the standing water.

Manufactured Home Case Study



- 1998 model home
- Uncomfortable - rain forest conditions (hot & humid)
- Walls starting to buckle
- $500+ peak utility bills

High bills, low comfort



Window treatments
2 additional window a/c units

Wall panels buckling

High bills, low comfort

- Building science problem solving
  - Testing (blower door, duct blaster, pressure mapping)
  - Observation
  - Documentation of operating conditions
- Findings: disconnected crossover duct
  - No cool air to one side of the house
  - Cool air spilling into crawl space
  - Super cooling surfaces – condensation, elevated RH, rust, rot, etc

Lessons for Crawl Space Ducts

- **<u>Replace disconnected duct material – contamination risk</u>**
- **<u>Duct connections need to be STRONG</u>**
  - Clean collar
  - Zip tie inner lining to metal collar with tensioning tool
  - Position insulation layer to completely cover the metal collar
  - Zip tie for outer lining to collar with tensioning tool
  - Best practice: connect outer lining to rigid/metal duct with mastic and fiberglass substrate

Lessons for Crawl Space Ducts

- **<u>Ducts need to be supported</u>**
  - Do not allow ducts to lay on the ground
  - For reference, Florida code for new construction: support straps every 6’
- **<u>Ducts need to be protected</u>**
  - Keep critters out of the crawl space

Not tightened with tensioning tool (from a different house)

- You shouldn’t be ale to get your fingers between duct and zip tie

Zip tie tensioning tool - “Cable tie gun”

- demo: https://www.youtube.com/watch?v=iBP7kMi-mN4

Well intended mastic sealing at flex to collar connection

- Well sealed
- BUT
- Compressed insulation led to condensation anyway
- Allow insulation and outer liner to be fully expanded around metal collar

Case Study, Port Fourchon, LA

- 12 single wide homes ”…moisture problems including high interior humidity, wall failures, and mold growth on floors and walls.”
- 2 or 3 BR, 1008 ft2, no ground cover
- Central split system HVAC
- Floor ducts, sheet metal trunk and risers

The situation

- Outside air 83 degrees 81% RH (dew point 76.6 degrees)
- Tstat set at 68 degrees – MOST SURFACES BELOW DEW POINT!
  - Soft interior wall panels
  - Exterior wallboard replaced
  - Material separation
  - Rust
  - Water in light fixtures

Moisture being pulled through wall cavity
Cool metal = condensation surface

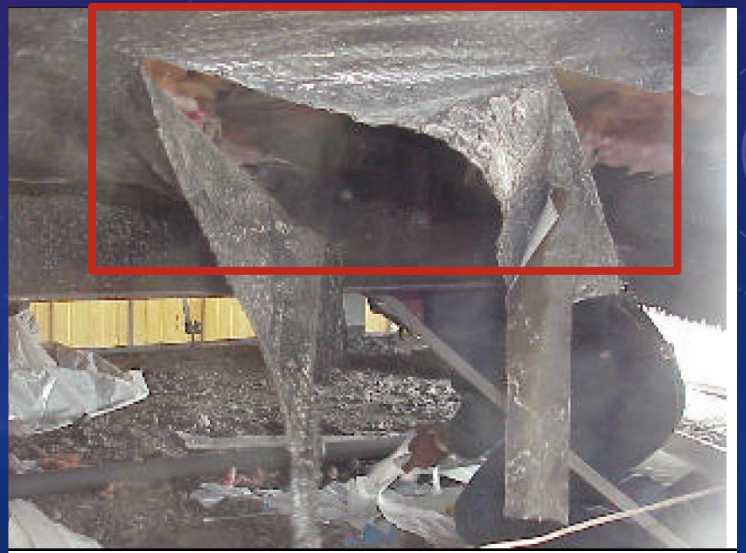
- “The electrical panel box showed significant evidence of moisture; there was rust on many parts and a water stain was seen below the panel running to the floor.”

Rust on electrical service panel

The situation

- Moisture sources
  - Condensation everywhere
  - Standing water everywhere
- Large opening in belly board
- Duct leakage causing infiltration of high humidity outdoor and crawl space air
- No return air pathways from bedrooms (doors always closed)
  - With AHU on, main body of house -8.5 pa wrt out

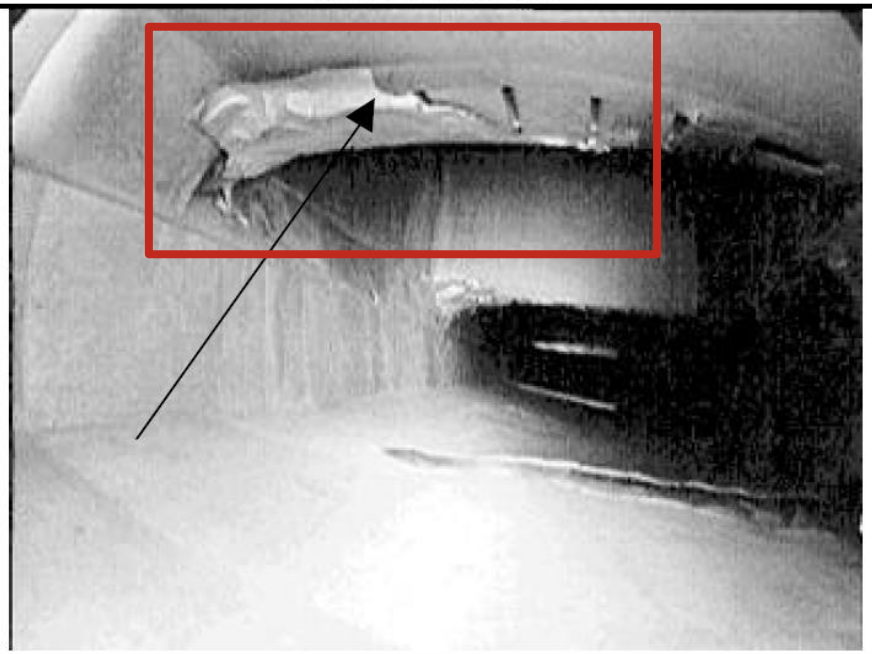
Standing water at skirting



One of many penetrations in belly board

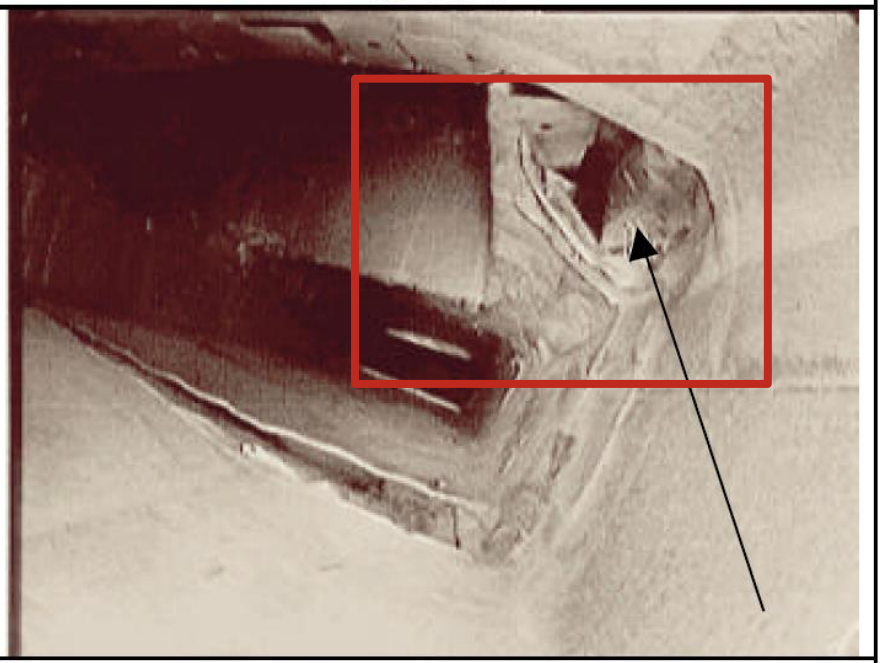
Duct leakage sites
Boots to sub floor, tape failures
Lessons: use mirror, cameras, smoke to find holes.
Seal connection of riser to trunk and to subfloor with mastic and fiberglass tape

and dormitories



View inside the duct- note missing tape

the duct.



View at plenum – note large hole

Lessons for very humid environments

- Keep the crawl space empty, dry, and vented
  - Direct runoff away from house
  - 6-mil visqueen or plastic sheeting over at least 90% of the exposed soil installed and protected against ponding
  - Vented skirting, 1 ft2 of vent area per 150 ft2 of floor area. (Current HUD code minimum is 1:150)
  - Sturdy, durable skirting – discourage critters
- Repair or add another layer of belly board
- Operating guidelines
  - Choose “auto”, not “fan on” mode
  - Thermostat set point no lower than 74
  - If lower than 74 is needed, consider a dehumidifier

Lessons for balancing pressure within conditioned space

- Keep supply air in the house
  - Seal risers to subfloor with mastic and fiberglass “tape”
  - Seal risers to trunk with mastic and fiberglass “tape”
- Add return air pathways to bedrooms
  - Allow air to leave bedrooms even when the doors are closed
  - Follow passive return air guidelines in Florida energy code
    - 1 square inch per cfm of supply air
    - 25 cfm supply to bedroom, 4x6 passive return grille or jump duct
  - Avoid louvered door returns and air handler stands
    - Create a dedicated return plenum with a filter back return grille

Mize, MS Double wide home

- 5 year old house, 3 bed, 2 bath
- 2 adults and one child
- Central heat, floor ductwork, down flow furnace

Mize, MS Double wide

- Biological growth, staining problems, and condensation on interior surfaces

SW corner bedroom-homeowner indicated that water runs down wall near corner

Mize, MS Double wide

- Water inside the hall light fixture and running out of electrical outlets located on the kitchen marriage line

Hallway ceiling fixture with evidence of moisture within the globe

Mize, MS Double wide

- Soft and bowing wallboard on the marriage line
- Staining at marriage line

"Staining" of ceiling near marriage line

Mize, MS Double wide

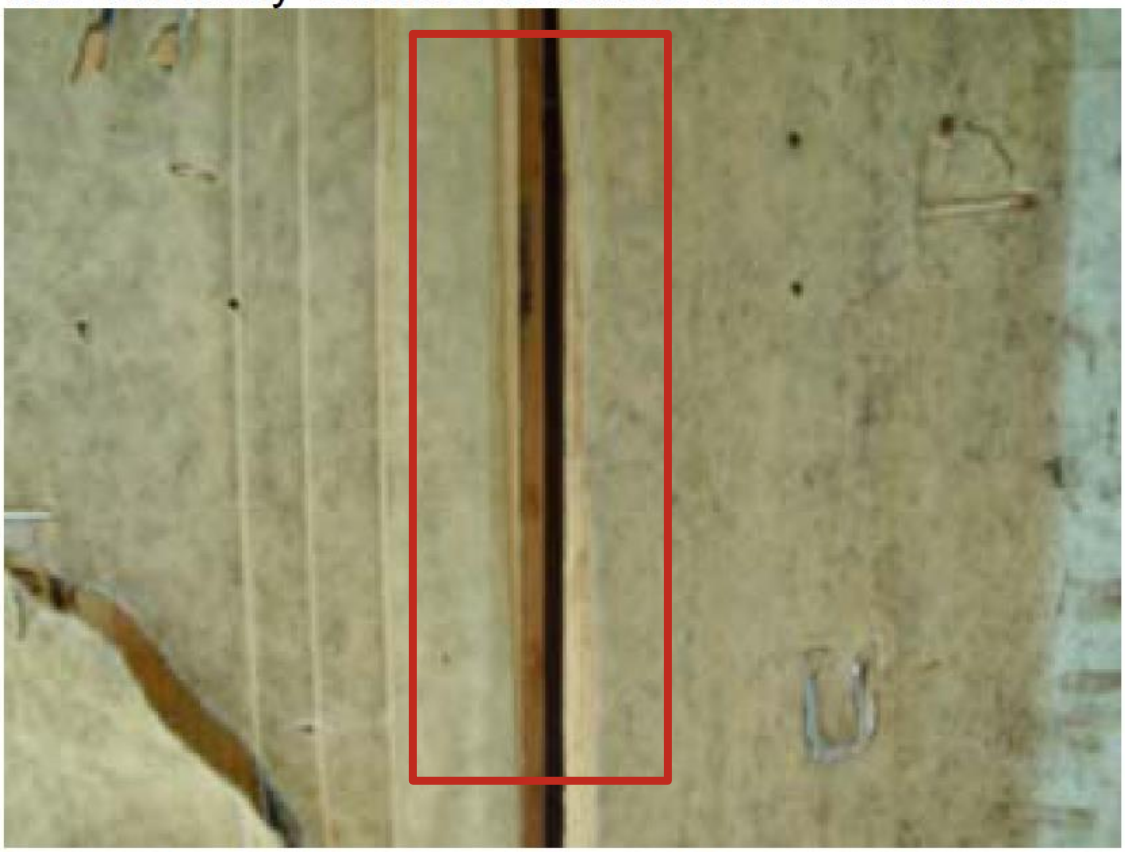
- Soft wall board, biological growth in wall cavity

Master bedroom marriage line wall doorknob damage as a result of humidified materials

Evidence of biological growth within the marriage line wall assembly common to master suite and kitchen.

Mize, MS Double wide

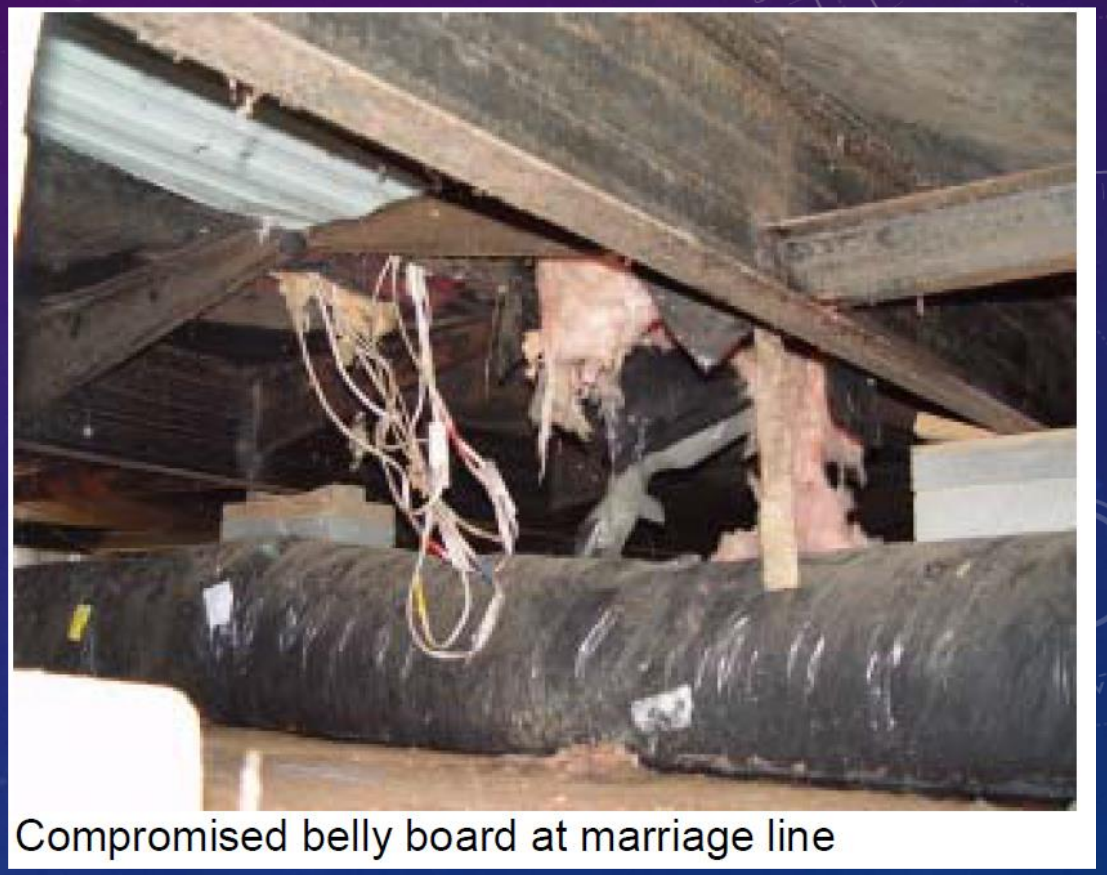
- The situation
  - No gasket at marriage line
  - Marriage wall fully connected to crawl space
  - Crawl space conditions fair/poor



East side marriage line – does not appear that any seal was installed or applied

Mize, MS Double wide

- Marriage wall fully connected to crawl space
- Missing belly board
- Missing insulation
- Duct sealing (tape) failure



Compromised belly board at marriage line

Mize, MS Double wide

- No ground cover, duct in contact with ground
- Could be worse! No standing water, tide lines, or growth

Crossover duct at air handler unit

Crossover duct under master suite

Lessons for moisture problems at marriage line

- Inspect marriage line in crawl space and at ceiling
- Where gasket is missing, fill spaces with air barrier material (rigid foam, sill seal, backer rod)
- Seal edges and joints of new air barrier material
  - Small cracks: long life caulk (e.g. silicone)
  - Larger cracks: mastic and fiberglass “tape” and long life sealant

- Changes in occupancy can bring on new moisture problems from additional cooking, bathing, and laundry
  - Install exhaust fans, duct to outside *not crawl space*

Lethal Failure: Depressurization is space with gas water heaters and furnaces

Flame Rollout and back drafting of exhaust fumes

Next Week's Training

Tyler Ardron with Risk Reduction Plus Group discusses changes to FEMA Flood Insurance

January 28 at 1:30 pm

Register at

https://attendee.gotowebinar.com/register/7166517154490879248

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Tin Can Tourists circa 1931

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