Humidity Control:
Tales From the Damp Side

2019 ENERGY STAR Residential New Construction Partner Meeting
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September 11th, 2019
Agenda

• Humidity Introduction
• Case Study: Multifamily Project
• Suggestions and Best Practices
• Closing Thoughts
• Questions
Humidity Introduction
Humidity Basics

- Air contains water
- We measure with relative humidity (0-100%)
- Hot air can hold more water than cold air
- When you cool air down it loses water (condensation)
Why do we care about high humidity?

• It’s uncomfortable!
• Excess moisture can lead to mold and other biological pollutants
  – Health concerns (e.g., asthma, allergies)
  – Building material decay
Symptoms

- Cold / clammy or humid and uncomfortable air
- Mold
- Drywall / building material discoloration or damage
- Condensation on ducts

Recommendations

- Generally < 60% RH is recommended
Balancing Act: Humidity = Moisture In – Moisture Out

Moisture In:
- Infiltration
- WH Ventilation
- Cooking
- Bathing
- Drying Bldg. Materials

Moisture Out:
- Air Conditioner
- Local Ventilation

Increasing Humidity
Building Loads / Equipment Capacity

- **Cooling Peak Load**: The maximum energy that’s added to the home in a single hour.
- **Sensible Cooling Load**: BTU’s added to home that increase temp.
- **Latent Cooling Load**: BTU’s added to home that increase humidity.
- **Cooling Capacity**: BTU’s per hour that equipment can remove.
Equipment sizing and dehumidification

Right-Sized AC

Oversized AC

Right-Sized Iced Tea
Efficient Homes & Humidity Control

- Efficient homes tend to decrease sensible load, but not latent load as much
  - Not just ENERGY STAR homes, modern code homes too!
- With relatively high latent loads, more likely to meet setpoint quickly, short cycle, and not dehumidify
3-Story Low-Rise MF Building in Delaware

- Climate Zone 4 (~4 miles from coast)
- 2012 IECC construction
- Summer 2018
- Various units were experiencing high indoor relative humidity (>70%) and mold growth
- Mold located at door frames, walls, and on absorbent materials (clothes, furniture, knickknacks)
- Field inspection and analysis determined a series of fundamental design, product selection, and installation errors to be the causal factors
- Two disclaimers before we continue:
  - NOT an ENERGY STAR project!
  - NOT designed or constructed with Rater’s involvement!
Heating & Cooling Equipment

• Engineer’s Sizing vs. Contractor’s Equipment Selection
  – EAM QC Manual J
• “Unrelated” Value Engineering Forcing MEP Design Changes
  – Return Ductwork Layout
• Engineer’s BOD Equipment Suitability to Architectural Layout
• Return Airflow Pathways
• Contractor “Fixes” Following Appearance of Issues
Let the errors begin…

- Misread of equipment model numbers
  - Plan: 1-ton AC (24k heating)
  - Installed: 2-ton AC (51k heating)
- Alteration of exterior balcony
  - Fiberglass to Composite Decking
These aren’t the numbers you’re looking for…

MODEL NUMBER GUIDE

H = Gas Heat
W = With
C = Electric Cooling

GAS HEAT EFFICIENCY
8 = 85% TE
9 = up to 95% TE

GAS HEAT FEATURE
N = Stainless steel heat exchanger
R = Aluminumized steel heat exchanger

GAS HEATING INPUT
24 = 24,000 Btu/hr
36 = 36,000 Btu/hr
48 = 48,000 Btu/hr
60 = 60,000 Btu/hr
22 = 22,000 Btu/hr
33 = 33,000 Btu/hr
44 = 44,000 Btu/hr
55 = 55,000 Btu/hr

Revision Code
Series

NOMINAL COOLING CAPACITY
12 - 12,000 Btu/hr
18 - 18,000 Btu/hr
24 - 24,000 Btu/hr
30 - 30,000 Btu/hr

P = 208/230 V - 60 Hz - 1 Ph

COOLING EFFICIENCY
09 = 9.2 EER
11 = Up to 11 EER
And this isn’t going to help either…
What happens in the home stays in the home…

No Kitchen Exhaust to Outside

Average Bath Fan Flow = 16 CFM
(as low as 10 CFM)
Implemented Solutions

- HVAC equipment swapped out
- Contractor “improvements” removed
- Tenant mechanical closet access removed
- Adequate return air pathway added between master bedroom and living space
- Bath fans replaced with a higher static 80 CFM model on delayed off switch
- Facility management keeping dehumidifiers onsite for spot use
- Tenant education (HVAC system operation, furniture placement, interior door positioning)
- Had Rater’s engineering department redo the MEP design for future buildings 😊
- **How was Summer 2019?**
Suggestions / Best Practices
Humidity Control Research & Low / No-Cost Solutions

• Mid-Atlantic builders in an ICF new homes EE program were having trouble with high humidity.
  – Wanted to know about ventilation, and options before an expensive dehumidification system.
• Recommendations summarized in a white paper.
• Make sure you do these right before jumping to supplemental dehumidification.
HVAC Solutions: Sizing

• Calculate accurate loads
  – Use industry standard practices
  – Ensure design = actual home
• Properly size equipment
  – Enough sensible and latent capacity
  – Limit oversizing!
• ENERGY STAR HVAC Design Report & Rater Design Review Checklist
HVAC Solutions: Commissioning

• Commission system to ensure equipment operates as designed
  – Duct leakage
  – Airflow
  – Refrigerant Charge
• ENERGY STAR HVAC Commissioning Checklist
HVAC Solutions: Sensible Heat Ratio (SHR)

- Lower SHR = more latent capacity
- Pay attention to SHR when selecting equipment.

- SHR and latent capacity change with conditions, consider evaluating off peak conditions.

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<th>Outdoor Temperature</th>
<th>SHR</th>
<th>Latent Capacity (kBtuh)</th>
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<table>
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<th>SHR</th>
<th>14 SEER</th>
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HVAC Solutions: Supply Fan Overrun

- Supply fan overrun: HVAC fan runs for a short period after compressor turns off
  - Provides a little extra cooling
  - Increases SEER rating
- Adds moisture back to the living space.

- Disable supply fan overrun if you struggle with humidity control.
  - 90 second fan overrun in Miami leads to 1,300 additional hours (53 days!) above 60% RH
Ventilation Solutions: Local Mechanical Exhaust

• Besides AC local exhaust is main way to remove moisture directly from the source
• Make sure to:
  – Measure airflow rate
  – Verify meets minimum rates
  – Verify exhausts directly outdoors
• ENERGY STAR Rater Field Checklist
Ventilation Solutions: Recommended Mechanical Ventilation Strategies

Exhaust

Supply

Balanced (ERV)

Hours

Modeled hours above 60% RH

https://www.nrel.gov/docs/fy14osti/60675.pdf
Homeowner Education Solutions

- Educate homeowners on how their actions can impact humidity control:
  - Use kitchen and bathroom ventilation, or use ventilation with humidistat controls
  - A higher cooling setpoint will mean less dehumidification
  - Set fan mode to “AUTO” not “ON”
You can meet code and program requirements and still sometimes get ducts that do this:
What to consider if low-cost & low-impact measures don’t work:

- Insulate ALL ductwork regardless of location
- Variable capacity AC equipment
- Install zoned or multiple systems
- Ductless HVAC systems
- Understand dedicated dehumidification systems may not be a luxury item in your area anymore
- Spray foam band joists
- Keep the major component specifications in line with each other (i.e. spend more on ventilation)
- Be willing to alter your build schedule and dehumidify during construction
- Restrict heating & cooling operation range
Closing Thoughts
Closing Thoughts

• Need to start to pay attention to and plan for humidity control, especially in efficient buildings.
• Complicated!
  – Additive risk factors.
  – Multiple options for improvement, unlikely to have one ‘silver bullet’.
• Handouts available.
Questions?
PSA: Help shape the future of ventilation!

- Steven Winter Associates is developing a new ventilation system: ERV that integrates with small, efficient heating & cooling systems.
- DOE-funded R&D project. More info [here](#).
- The prototype:
  - 50-120 CFM of balanced ventilation
  - 40-80 watts, including the air-handler unit fan power
  - Sensible recovery of 70%@120 CFM; >80%@50 CFM
  - Total energy recovery of 45%@120 CFM; 60%@50 CFM

They want your input: complete 5-10 minute anonymous survey to share your experiences with residential ventilation.