# Humidity Control: Tales From the Damp Side

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

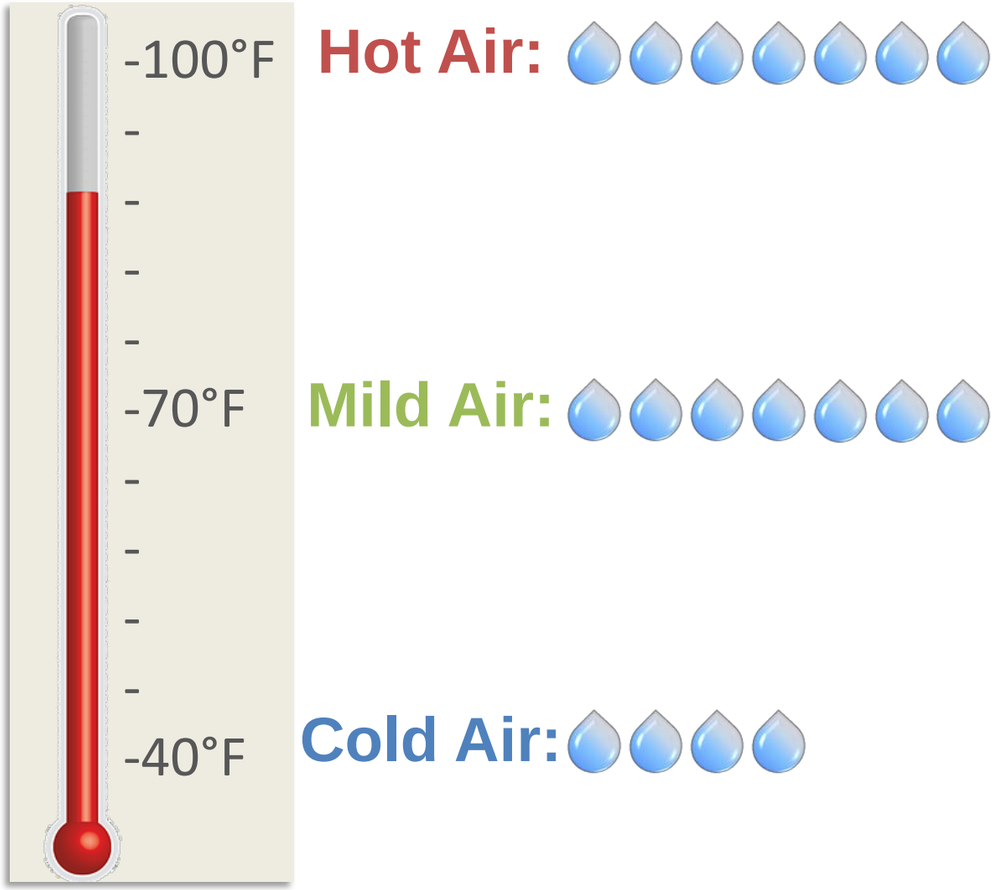
# Agenda

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

# Humidity Introduction

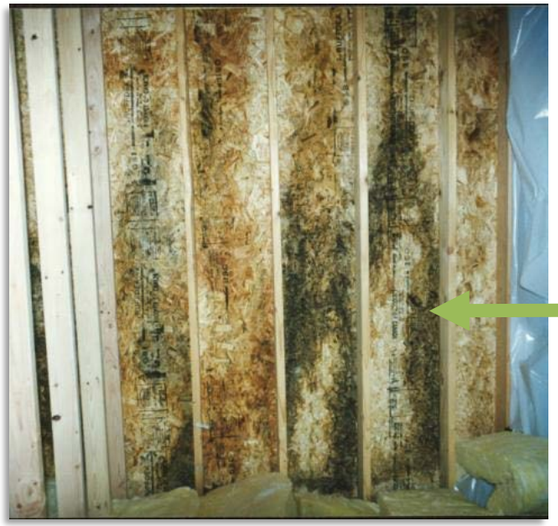
# Humidity Basics

- 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



Mold

## Symptoms

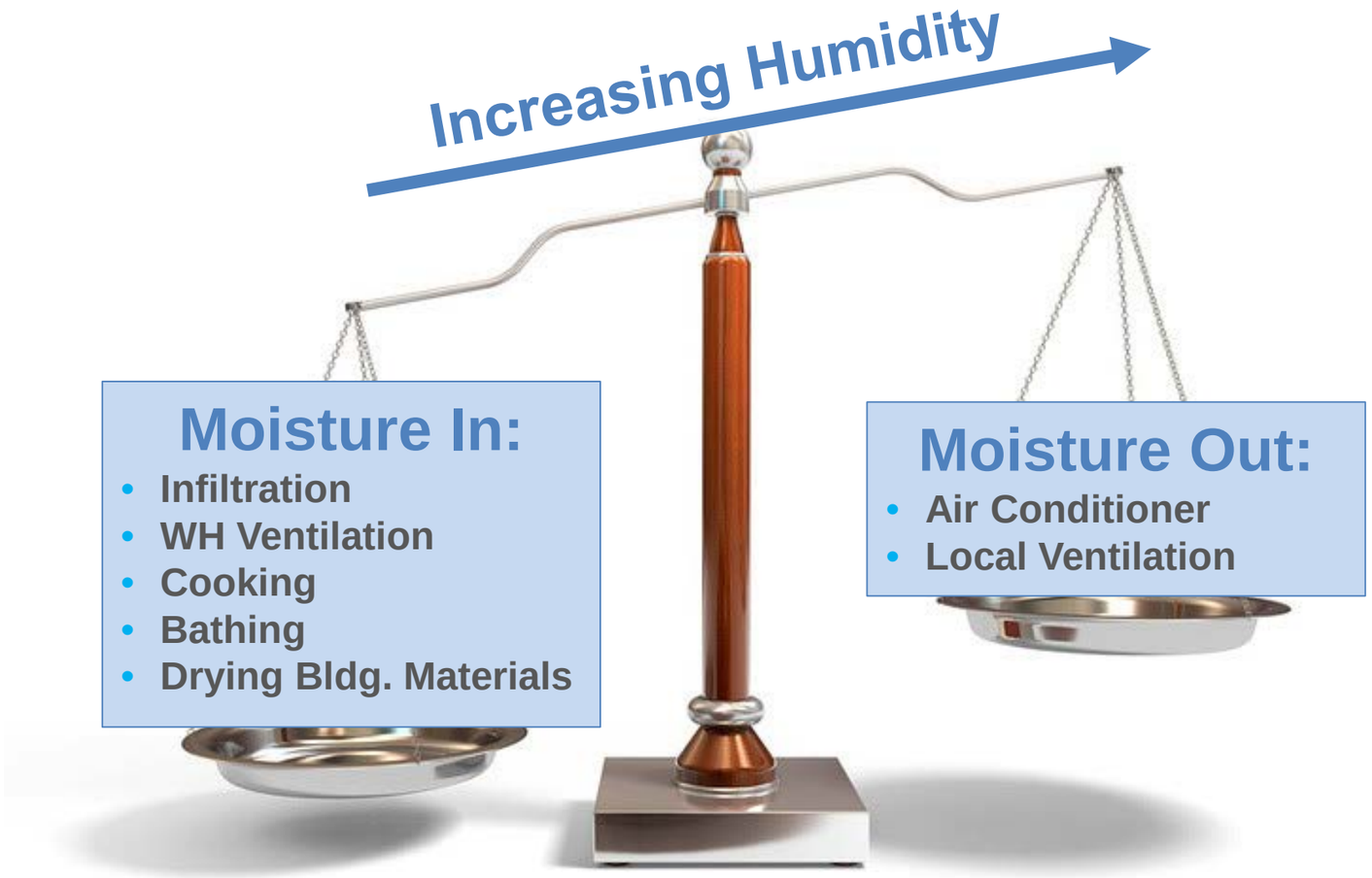
- Cold / clammy or humid and uncomfortable air
- 

- Drywall / building material discoloration or damage
- Condensation on ducts

## Recommendations

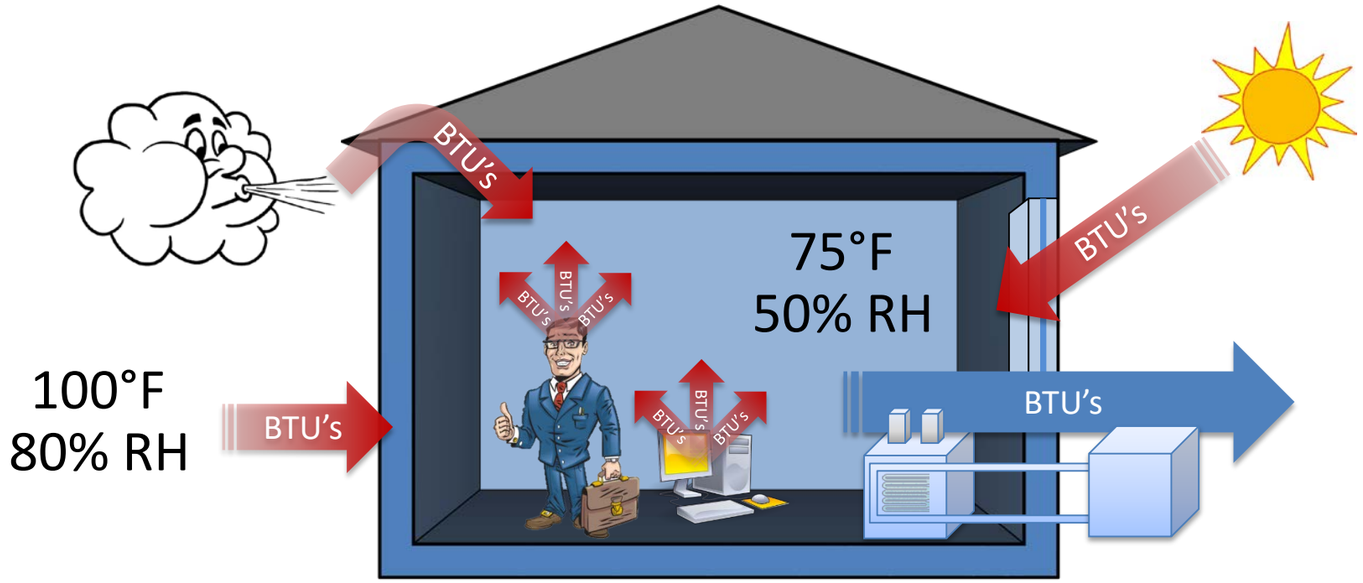
- Generally < 60% RH is recommended

# Balancing Act: Humidity = Moisture In – Moisture Out



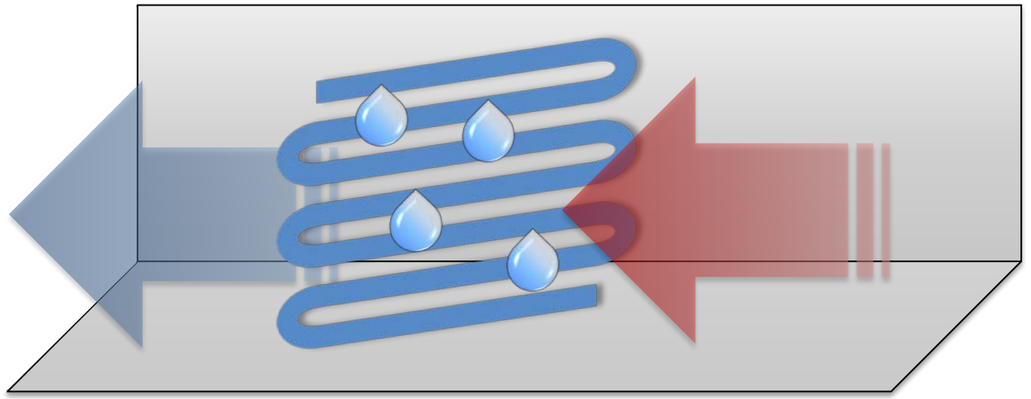
# Building Loads / Equipment Capacity

- 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.

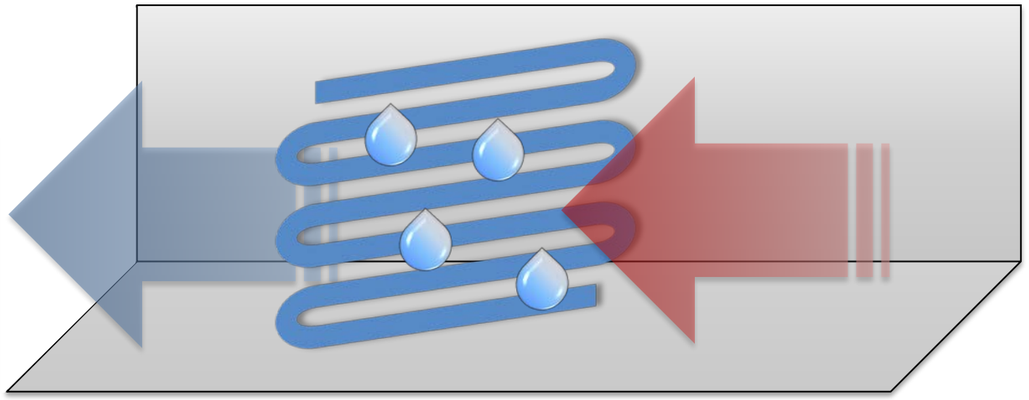


# Equipment sizing and dehumidification

Right-Sized AC



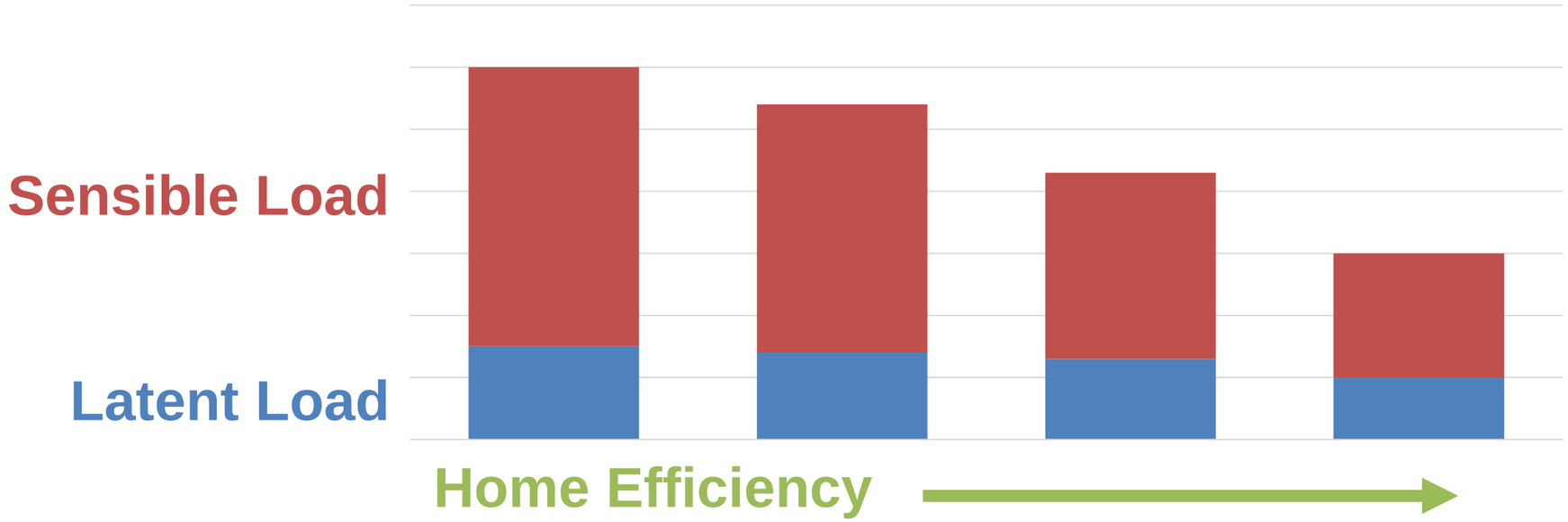
Oversized AC



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



# Case Study: Multifamily Project

# 3-Story Low-Rise MF Building in Delaware

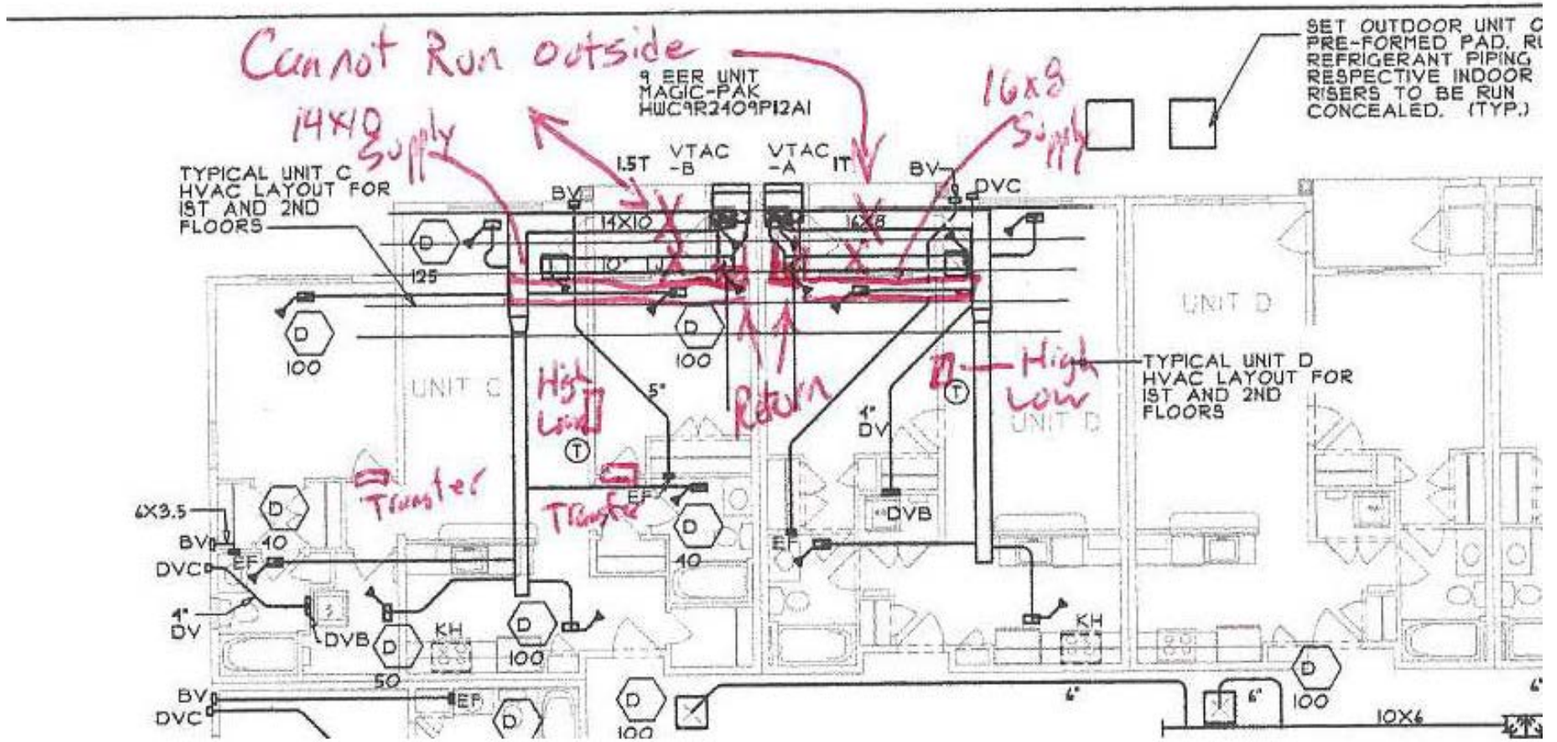
- Climate Zone 4 ( ~4 miles from coast)
- 2012 IECC construction
- Summer 2018
- Various units were experiencing high indoor relative humidity ( >70%) and mold growth
- Mold located at door frames, walls, and on absorbent materials (clothes, furniture, knickknacks)
- Field inspection and analysis determined 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 W C 9 N 55 11 P 18 A 1**

- H = Gas Heat
- W = With
- C = Electric Cooling
- **GAS HEAT EFFICIENCY**
  - 8 = 80% TE
  - 9 = up to 95% TE
- **GAS HEAT FEATURE**
  - N = Stainless steel heat exchanger
  - R = Aluminized 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
- **COOLING EFFICIENCY**
  - 09 = 9.2 EER
  - 11 = Up to 11 EER
- P = 208/230 V - 60 Hz - 1 Ph
- **NOMINAL COOLING CAPACITY**
  - 12 - 12,000 Btu/hr
  - 18 - 18,000 Btu/hr
  - 24 - 24,000 Btu/hr
  - 30 - 30,000 Btu/hr
- Series
- Revision Code

# 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

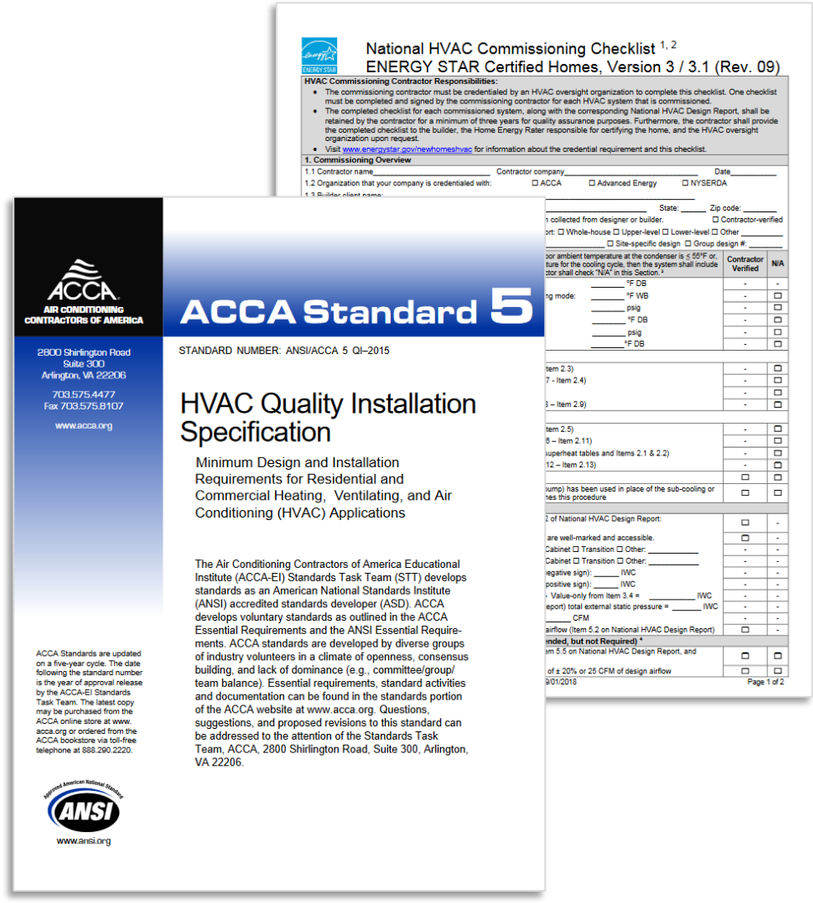
- Mid-Atlantic builders in an ICF new homes EE program were having trouble with high humidity.
  - Wanted to know about ventilation, and options before an expensive dehumidification system.
- Recommendations summarized in a white paper.
- Make sure you do these right before jumping to supplemental dehumidification.

# 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**


National HVAC Commissioning Checklist [1, 2]
ENERGY STAR Certified Homes, Version 3 / 3.1 (Rev. 09)

HVAC Commissioning Contractor Responsibilities:

- The commissioning contractor must be credentialed by an HVAC oversight organization to complete this checklist. One checklist must be completed and signed by the commissioning contractor for each HVAC system that is commissioned.
- The completed checklist for each commissioned system, along with the corresponding National HVAC Design Report, shall be retained by the contractor for a minimum of three years for quality assurance purposes. Furthermore, the contractor shall provide the completed checklist to the builder, the Home Energy Rater responsible for certifying the home, and the HVAC oversight organization upon request.
- Visit www.energystar.gov/newhomeshvac for information about the credential requirement and this checklist.

1. Commissioning Overview

1.1 Contractor name_____ Contractor company_____ Date_____

1.2 Organization that your company is credentialed with: ☐ ACCA ☐ Advanced Energy ☐ NYSERDA

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ACCA Standards are updated on a five-year cycle. The date following the standard number is the year of approval release by the ACCA-EI Standards Task Team. The latest copy may be purchased from the ACCA online store at www.acca.org or ordered from the ACCA bookstore via toll-free telephone at 888.290.2220.

ANSI
www.ansi.org

ACCA Standard 5

STANDARD NUMBER: ANSI/ACCA 5 QI–2015

HVAC Quality Installation Specification

Minimum Design and Installation Requirements for Residential and Commercial Heating, Ventilating, and Air Conditioning (HVAC) Applications

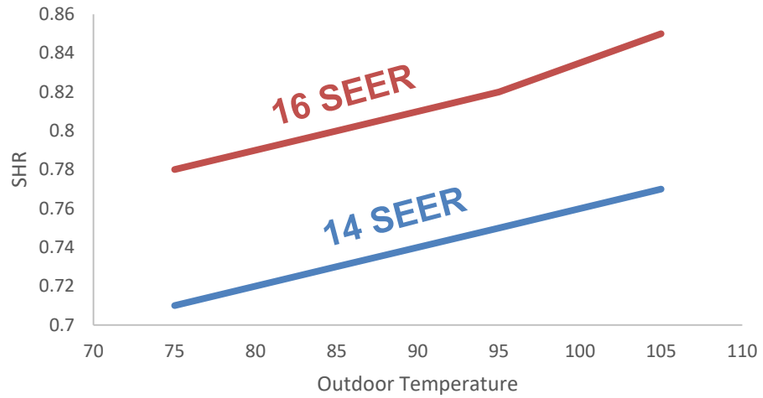
The Air Conditioning Contractors of America Educational Institute (ACCA-EI) Standards Task Team (STT) develops standards as an American National Standards Institute (ANSI) accredited standards developer (ASD). ACCA develops voluntary standards as outlined in the ACCA Essential Requirements and the ANSI Essential Requirements. ACCA standards are developed by diverse groups of industry volunteers in a climate of openness, consensus building, and lack of dominance (e.g., committee/group/team balance). Essential requirements, standard activities and documentation can be found in the standards portion of the ACCA website at www.acca.org. Questions, suggestions, and proposed revisions to this standard can be addressed to the attention of the Standards Task Team, ACCA, 2800 Shirlington Road, Suite 300, Arlington, VA 22206.

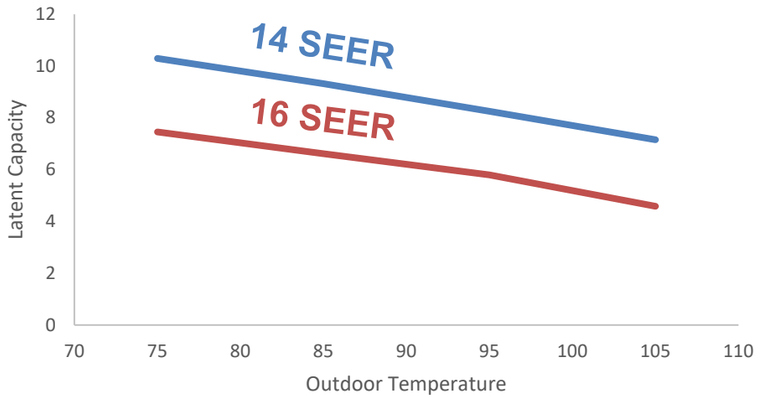
# HVAC Solutions: Sensible Heat Ratio (SHR)

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

| | 14 SEER | 16 SEER |
|---|---|---|
| Nominal Capacity (Tons) | 3.0 | 3.0 |
| SHR | 0.75 | 0.82 |
| Latent Capacity (kBtuh) | 9.0 | 6.5 |

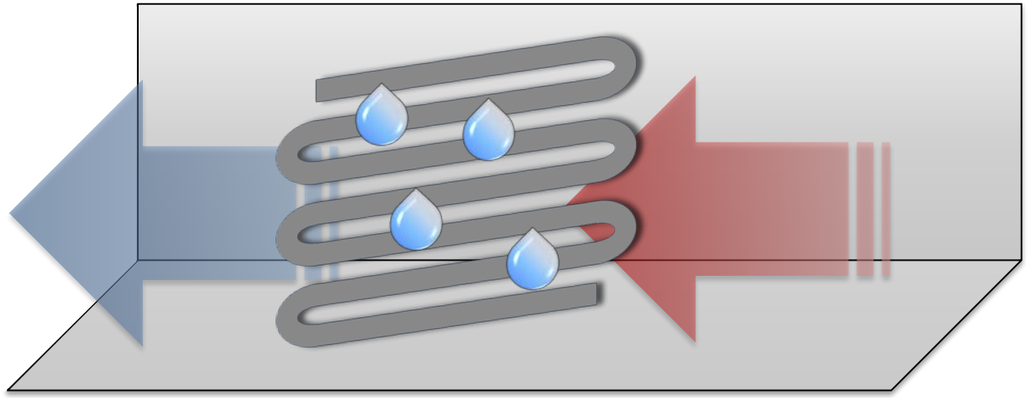
- SHR and latent capacity change with conditions, consider evaluating off peak conditions.



# 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.

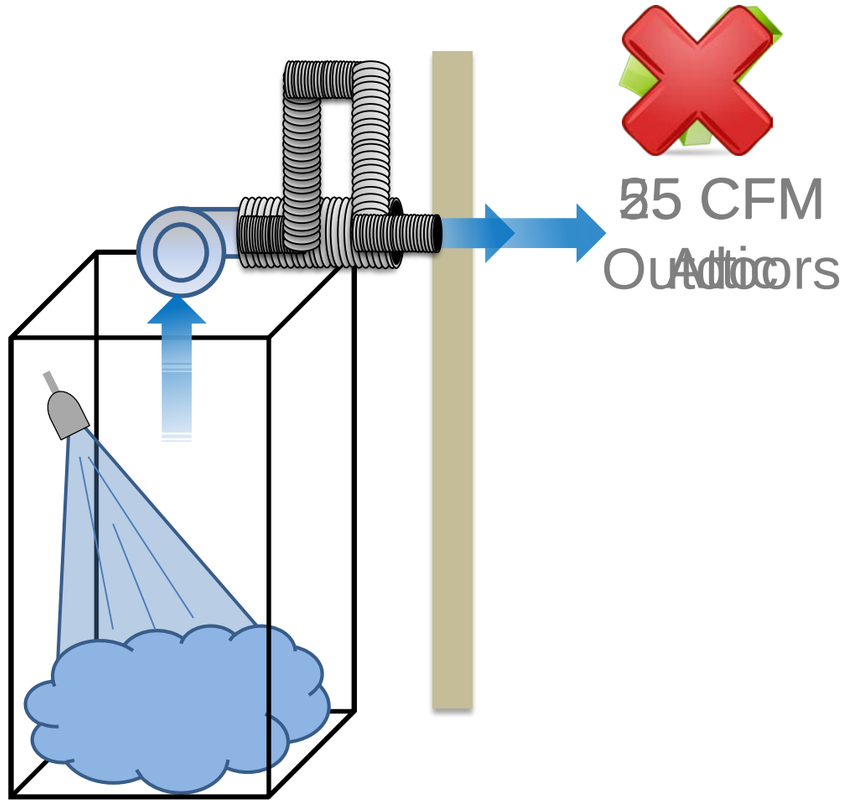


- Disable supply fan overrun if you struggle with humidity control.
  - 90 second fan overrun in Miami leads to 1,300 additional hours (53 days!) above 60% RH

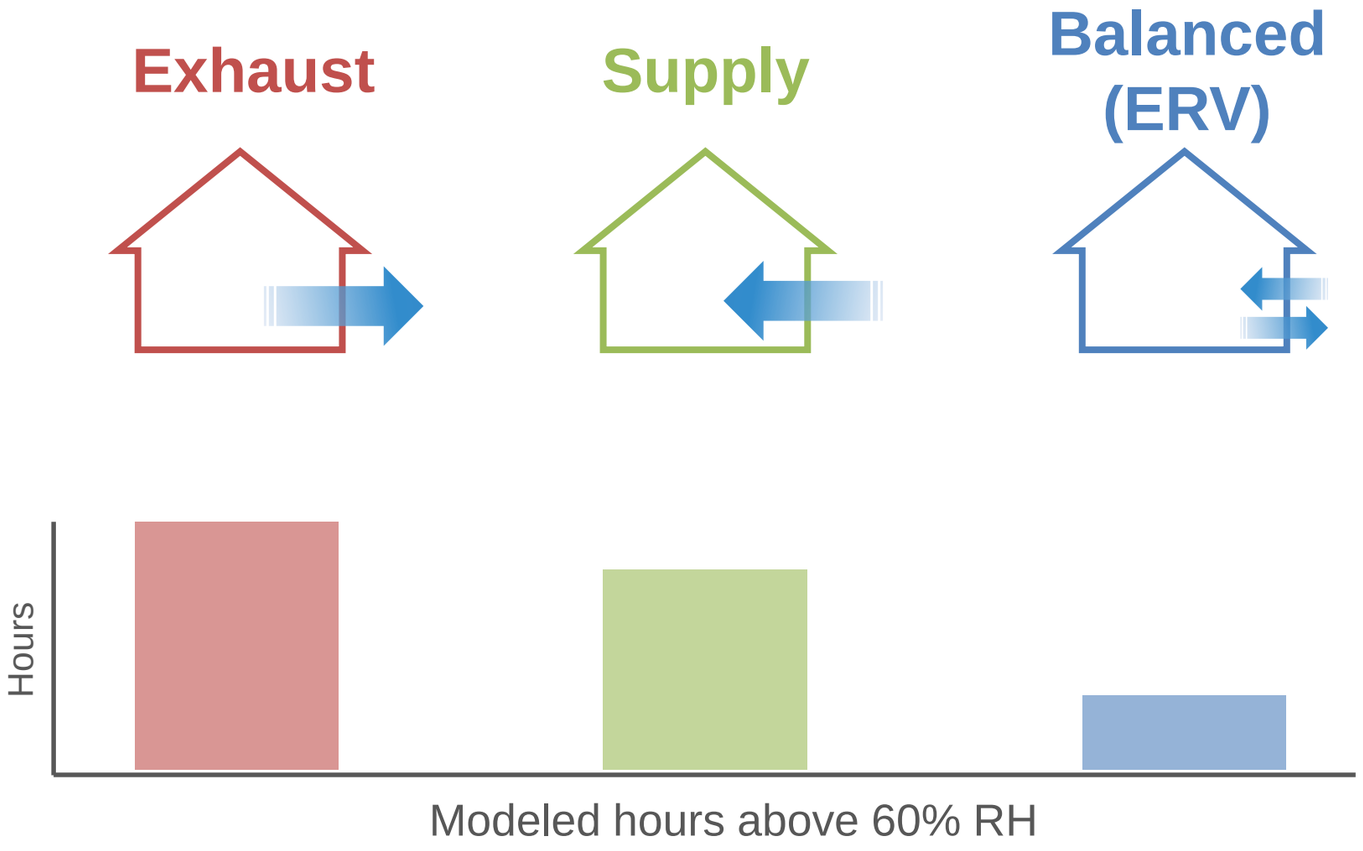
http://publications.energyresearch.ucf.edu/wp-content/uploads/2018/06/FSEC-PF-443-08.pdf
http://www.fsec.ucf.edu/en/publications/pdf/FSEC-CR-1716-07.pdf

# 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**



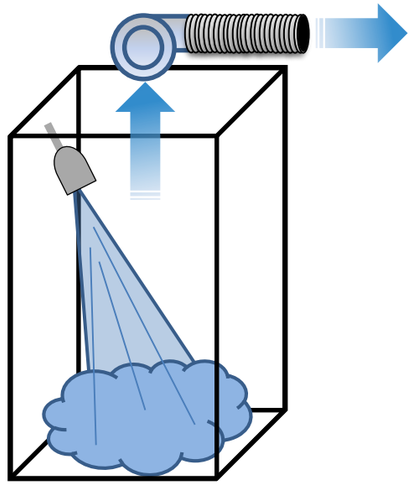
# Ventilation Solutions: Recommended Mechanical Ventilation Strategies

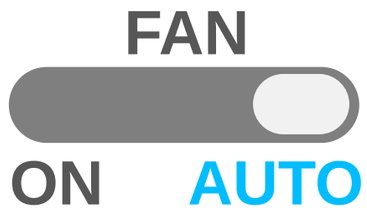



https://www.nrel.gov/docs/fy14osti/60675.pdf

# 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.