

Thinking Outside (Below) the Box: Basement Indoor Air Quality Problems & Solutions

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SANTA-FE™

INDOOR AIR QUALITY SOLUTIONS



Therma-Stor® LLC

Driven by performance. Powered by design.™



SANTA-FE
DEHUMIDIFIERS

Basements and Crawlspace

Whole House Ventilating Dehumidification



QUEST
DEHUMIDIFIERS

HI-E DRY

Commercial Climate Control



Restoration Equipment



- Involved in the indoor air quality industry for 15+ years
- A RESNET certified home energy rater
- Member of the ACCA Manual Low Load Homes (LLH) Advisory Committee
- Completed the ACCA Residential Design for Quality Installation Certification
- Developed a two-day hands-on crawl space encapsulation training program
- Active member of the Spray Polyurethane Foam Association (SPFA)

Definitions and Terminology



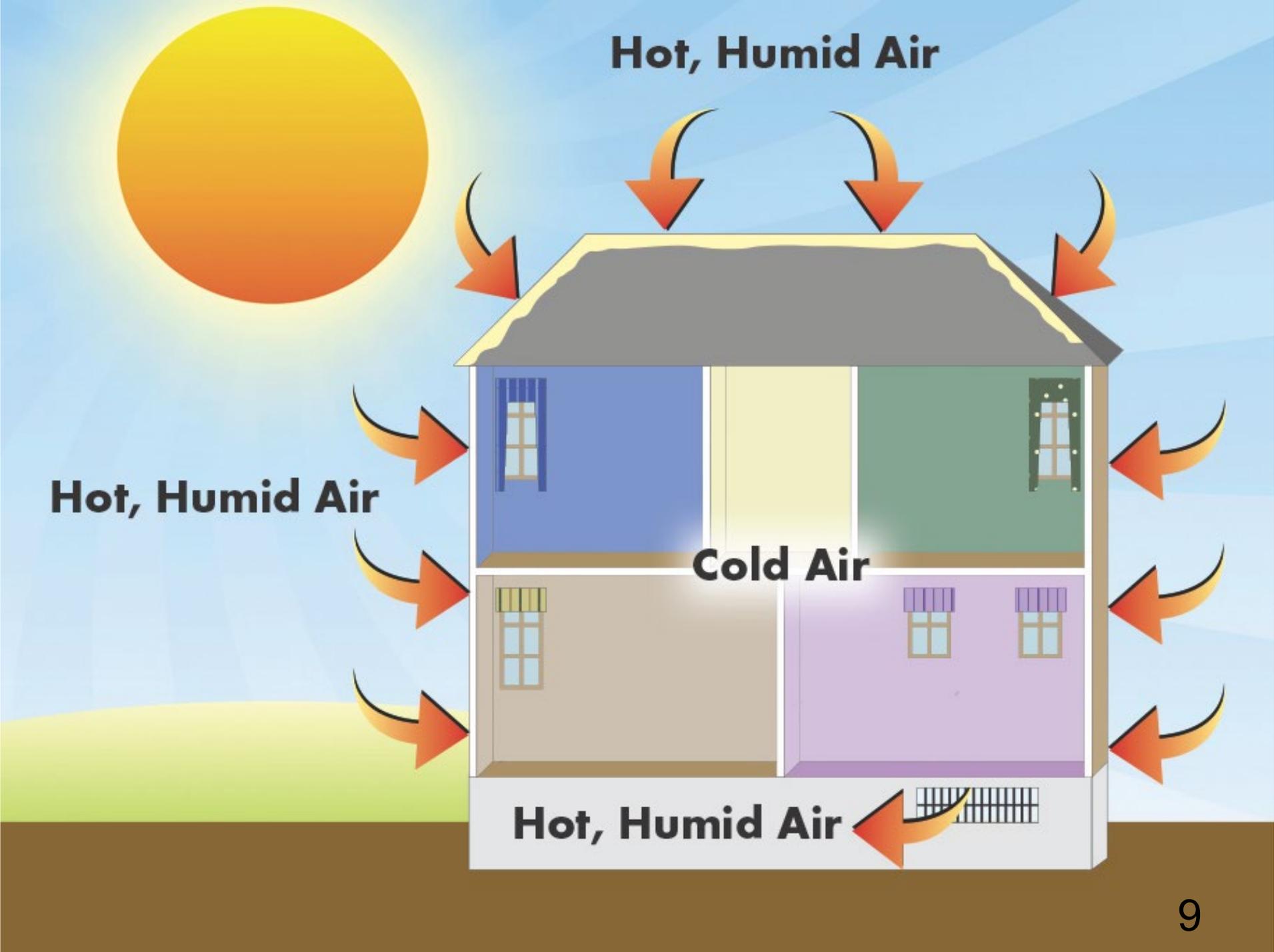
A pint is a pound the world
around



It takes approximately 1,054
btus to remove one pint of
water



1 cfm out = 1 cfm in



Reverse Stack Effect - Summer

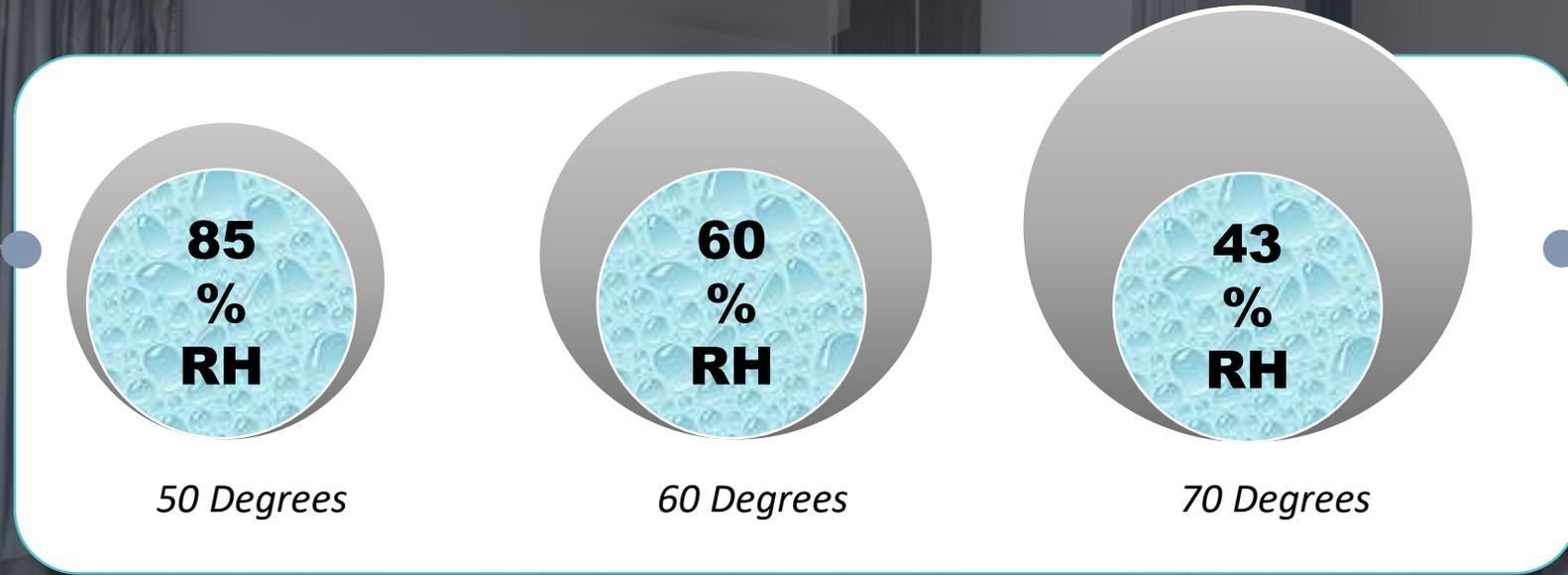


Stack Effect - Winter



Relative Humidity

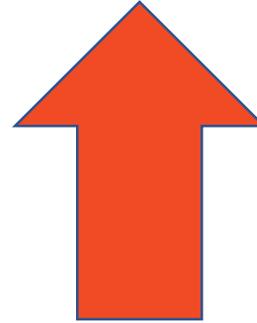
Humidity is relative to the temperature



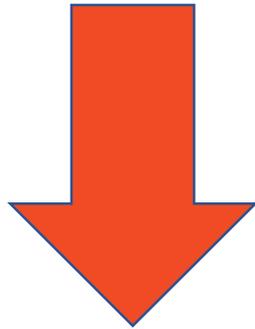
While the amount of water in the air remains the same, the % of the air that the water occupies changes with the temperature; therefore, the amount of space that the water occupies is relative to the temperature of the air.

Definitions and Terminology

Every degree the temperature



Relative humidity

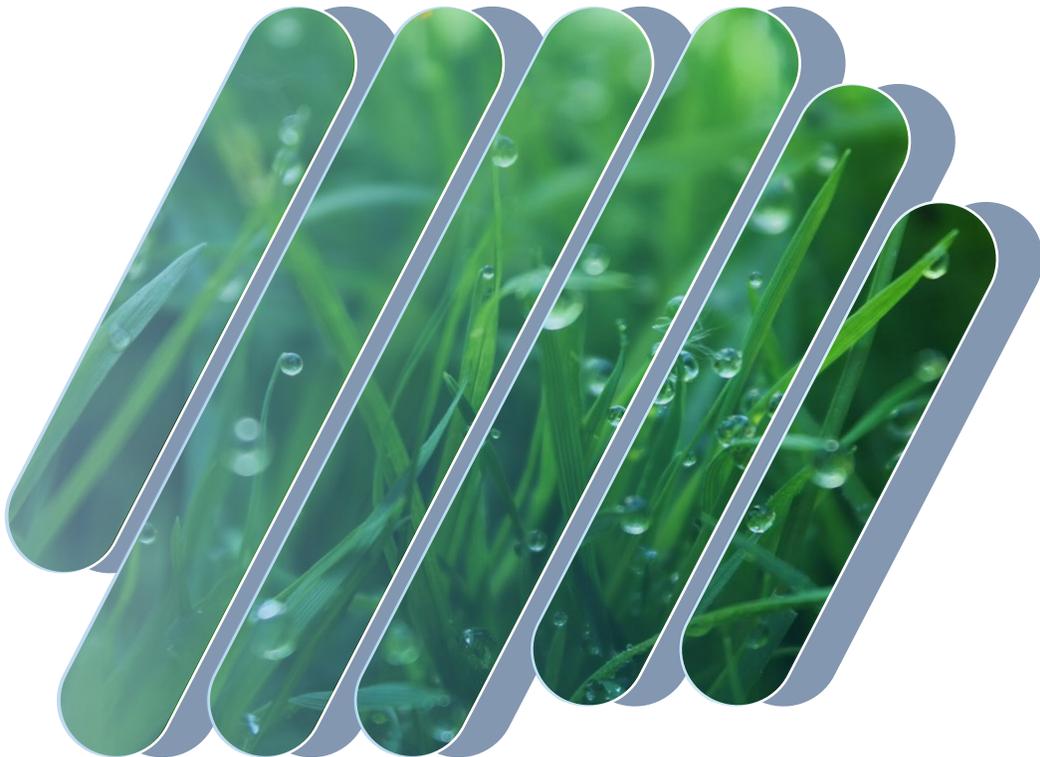


2%

Vice versa



Dew Point



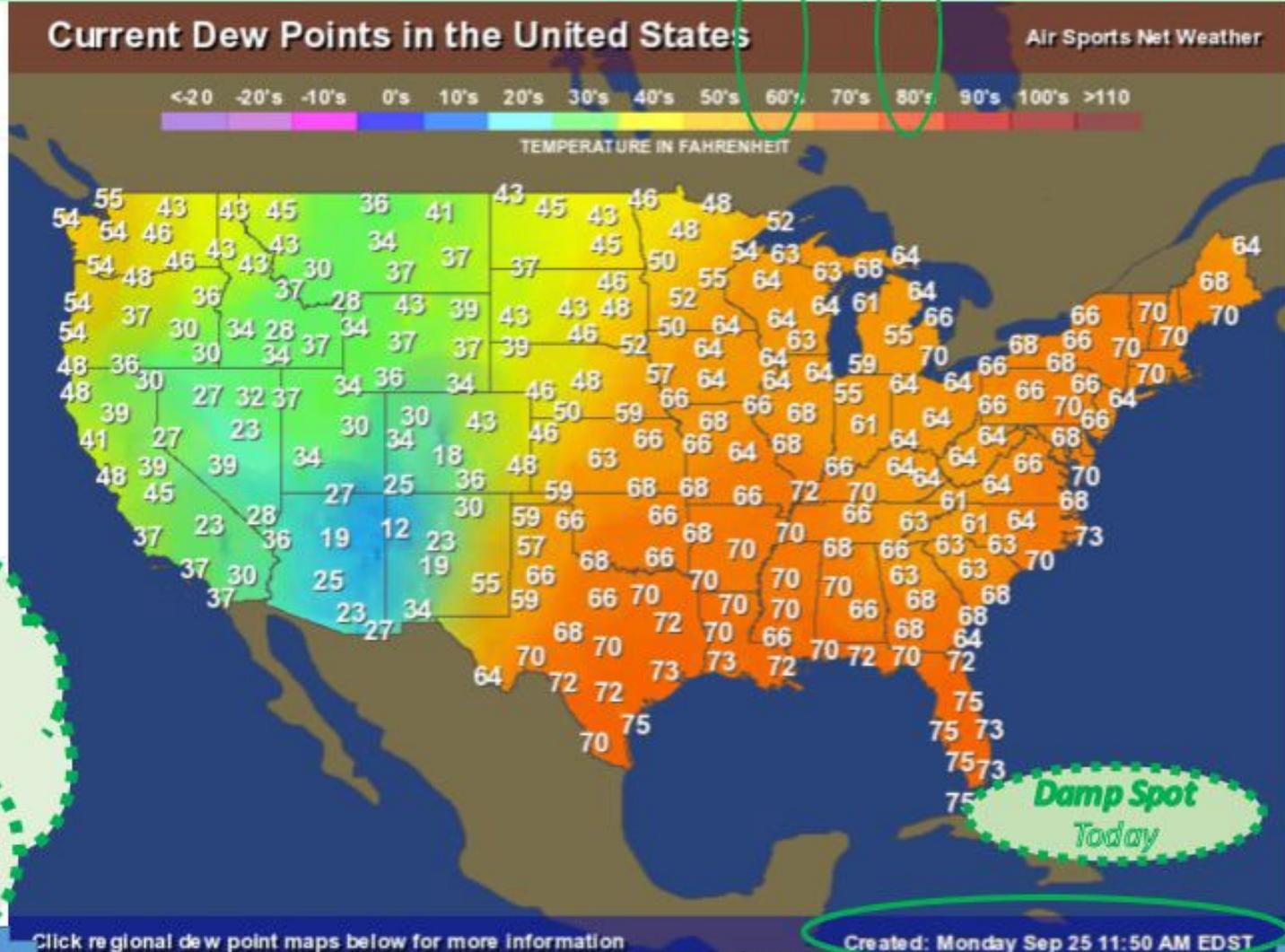
The dew point is what the air temperature would have to be for relative humidity to be at 100%.



Unlike RH, the dew point does not change with air temperature. In that sense it is an “absolute” measurement of the amount of water vapor in the air.

Dew Points Across The Nation

Dehumidification to maintain 75°F, 50%RH, 55°F dew point -- 0 1 3 6 Lbs. per hour per 100 CFM



Click regional dew point maps below for more information
<http://www.usairnet.com/weather/maps/current/dew-points/>



Welcome to the Dew Point Calculator

Use the sliders to explore combinations of temperature (T), relative humidity (RH), and dew point (DP) to compare the preservation quality of your environment. Knowing the dew point can help achieve long-term preservation of collection materials for libraries, museums, and archives. To report on your storage environment use a datalogger to record data and [eClimateNotebook®](#) to analyze it.

Click to Solve for:

Temperature % RH Dew Point

70

100

70



Preservation Evaluation

Type of Decay	Environment Rating	Preservation Metric	
Natural Aging	RISK	PI	12
Mechanical Damage	RISK	% EMC	28.8
Mold Risk	RISK	Days to Mold	2
Metal Corrosion	RISK	% EMC	28.8

Record and Compare Values

T	RH	DP	PI	Days to Mold	EMC

Why Do I Have Condensation?

If the dew point is above
the surface temperature,
condensation will occur



SURFACE TEMPERATURE



If the dew point is below
the surface temperature,
there will be no condensation



A typical basement in a green grass climate without a dehumidifier will be around 65F and between 65-75% relative humidity during the spring, summer, and fall months. These conditions will result in a dew point between 53F – 57F dew points.

Why Indoor Air Quality is Important



Indoor Air Quality has been ranked among the top 5 environmental risks of public health by the EPA.



6 out of 10 homes are hazardous to their occupants' health.



1 in 5 people have either allergies or asthma.

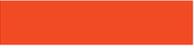


Up to 50% of all illnesses can be attributed to indoor air quality issues.



70X more hazardous pollutants are found in indoor air than outdoor air.





Why Basement Indoor Air Quality Needs to Be Addressed Separate From The Rest of the Home

- Built in the ground
 - Soil temperatures several feet below the surface remain at a constant temperature of 50°- 60°F or less
 - Foundations will shift
 - No solar heat gain
 - High humidity
 - Lack of controlled mechanical ventilation
 - HVAC system is designed for above ground living space
 - Where is the thermostat located?
- 

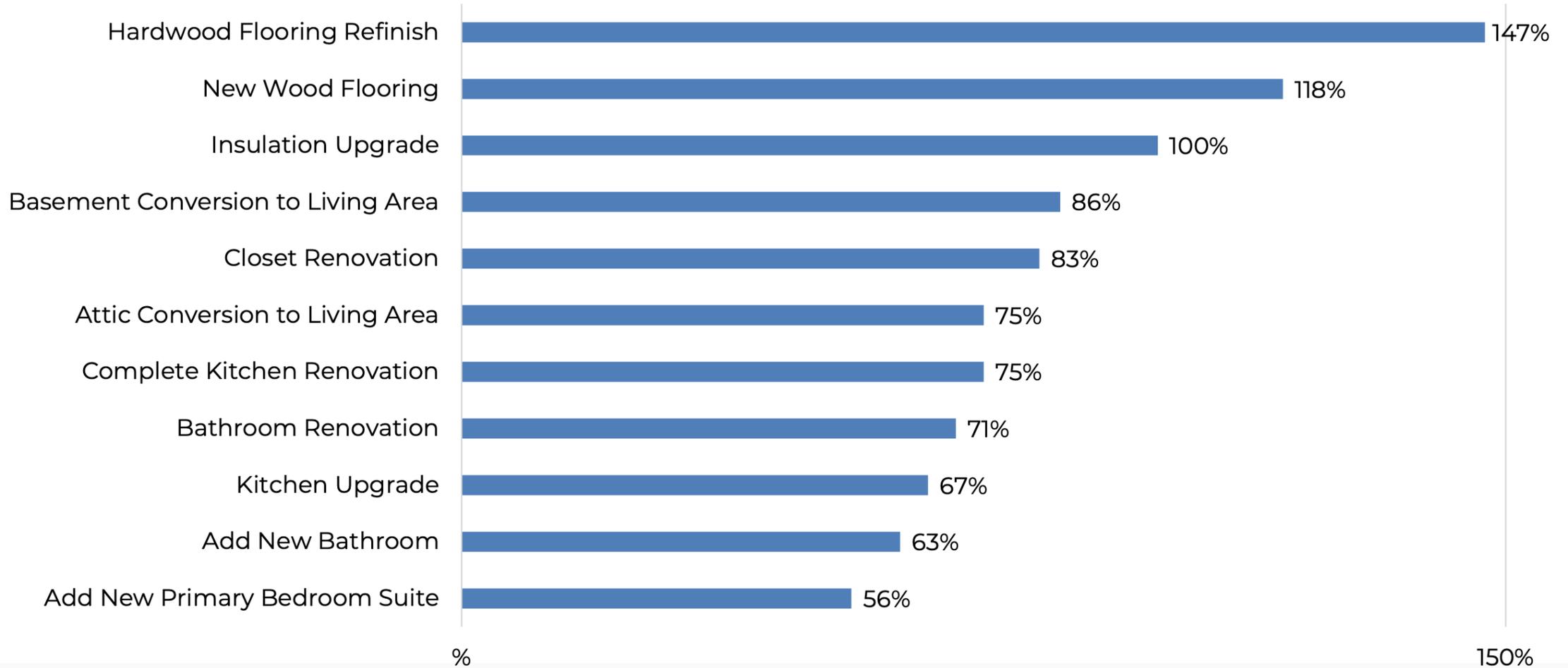


2022 Basement Remodeling Trends

- Entertainment Spaces
 - Dedicated Home Offices
 - Home Gym
 - Home Theater
 - Playroom
 - Guest Suites
 - Music Room
 - Sports Room
 - Teen Hangout
 - Laundry Room
 - Storage/Utilities
- 

Cost Recovery for Interior Remodeling Projects

Cost Recovery On Interior Projects



The Need For Dehumidification Is Significant

High indoor humidity levels affect:



Health



Comfort



Personal
belongings



Structure of the
home

- *American Medical Association*
- *American Lung Association*
- *EPA*

Less than 50% RH

ASHRAE

Less Than 60% RH

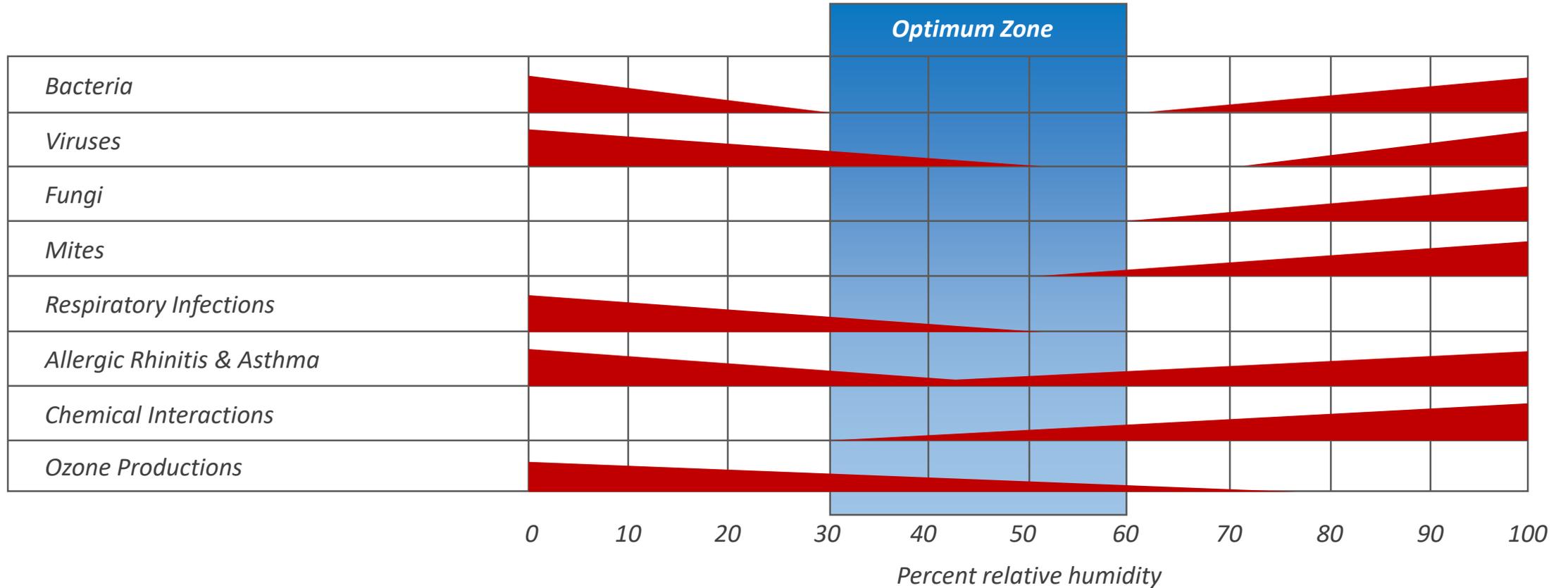
Building Science Corporation

“Most comfortable when the relative humidity range is between 25-60%”

Health & Wellbeing

*Optimum relative humidity range to minimize harmful contaminants**

(a decrease in bar height indicates a decrease in effect for each of the items)



*ASHRAE: American Society of Heating, Refrigeration & Air Conditioning Engineers



Mold spores and dust mites thrive when the relative humidity exceeds 60% for a sustained period of time.



Dust Mites

- Common household dust mites may be a factor in as many as 80 percent of asthmas, hay fevers and other allergic ailments.
- Dust mite allergens are considered one of the most potent allergens in household dust.
- People are allergic to dust mite droppings, not the dust mites themselves.
- Dust mites are microscopic hardy creatures that live and multiply easily in warm, humid places.
- They die when the humidity falls below 50 percent.
- Adults spend one-third of their time and children spend half of their time in their bedrooms, so it is important that you take steps to prevent allergens in this room.



Off-Gassing

Relative humidity also affects the rate of off-gassing of formaldehyde and other volatile organic compounds (VOC) from indoor building materials and furniture. Chemicals will off-gas faster and more under high humidity.





Sources of Moisture

Construction Moisture

Regardless of the type of wood frame construction, as much as a ton of moisture (2,000 pounds) can be released by the lumber, concrete foundation, and drywall as they dry out.

Seasonal Storage Effect

Combining the moisture released from the lumber, gypsum, furniture and concrete of a house, these sources are releasing from 6 – 16 pints of water per day from seasonal storage only.

Basements or Crawl Spaces

Crawl space with no vapor barrier 84 – 105 pints per day
Basement 4-6 pints diffusing per day through walls and floor



High Humidity Control Strategies

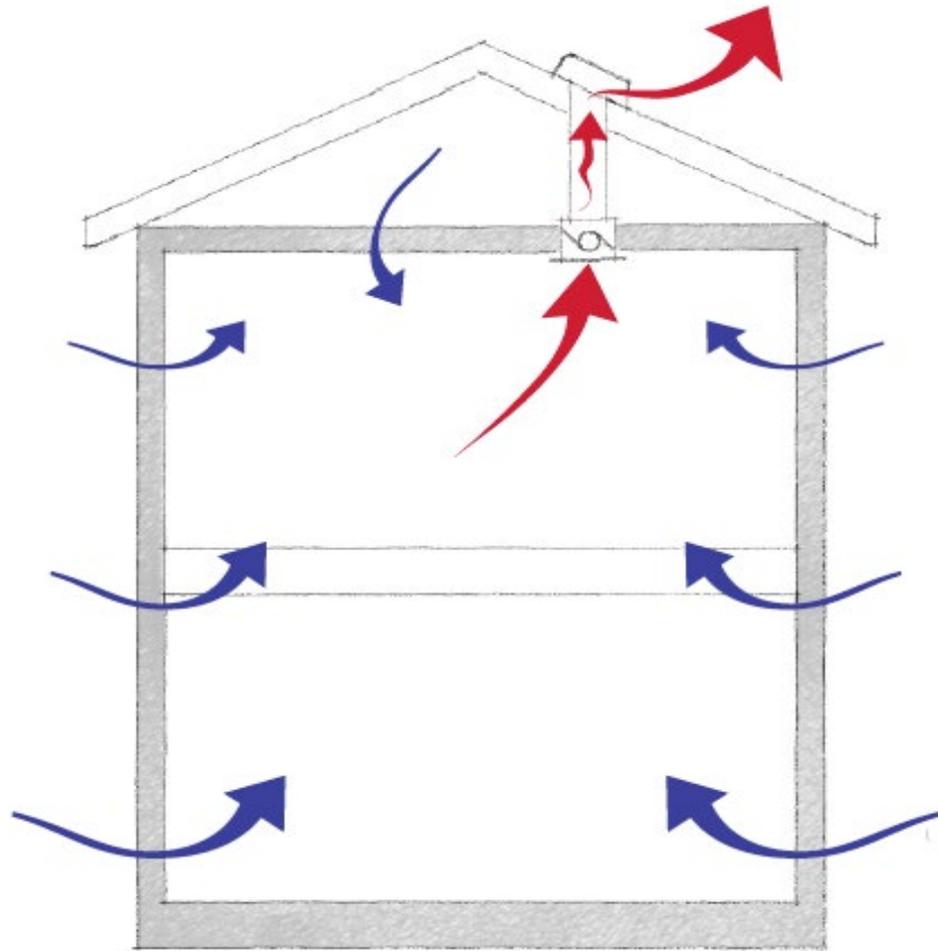
Ventilation

HVAC System

Dehumidification



Ventilation - Exhaust



1 cfm out = 1 cfm in

Beware These 3 Expensive Ventilation System Ripoffs



How much does an exhaust fan cost? Search online and you can find lots of them that move 200 cubic feet per minute (cfm) for \$100 to \$150. But, if you put one in a semi-attractive (emphasis on the "semi") package, create some fancy marketing materials, and target people who don't know much building science, you can charge \$1200 to \$1700 for that same fan. At least that seems to be the business plan for these three companies.

I found out about them only recently, but a quick search online shows that people have been discussing whether or not they work at least as far back as 2008. The systems I'm talking about are made by WAVE, EZ Breathe, and Humidex, and, for most people in the US, they won't work as promised.

These systems are nothing more than glorified exhaust-only ventilation systems. The main target for these companies is someone with a humid, musty smelling basement or a damp crawl space. They promise that by exhausting air from the basement or crawl space, dry, conditioned air from the living space above will be brought down into the basement or crawl space. The result is a dry basement or crawl space. Or so they'd have you believe.

STEP 1 - Expel



STEP 2 - Replenish



STEP 3 - Ventilate



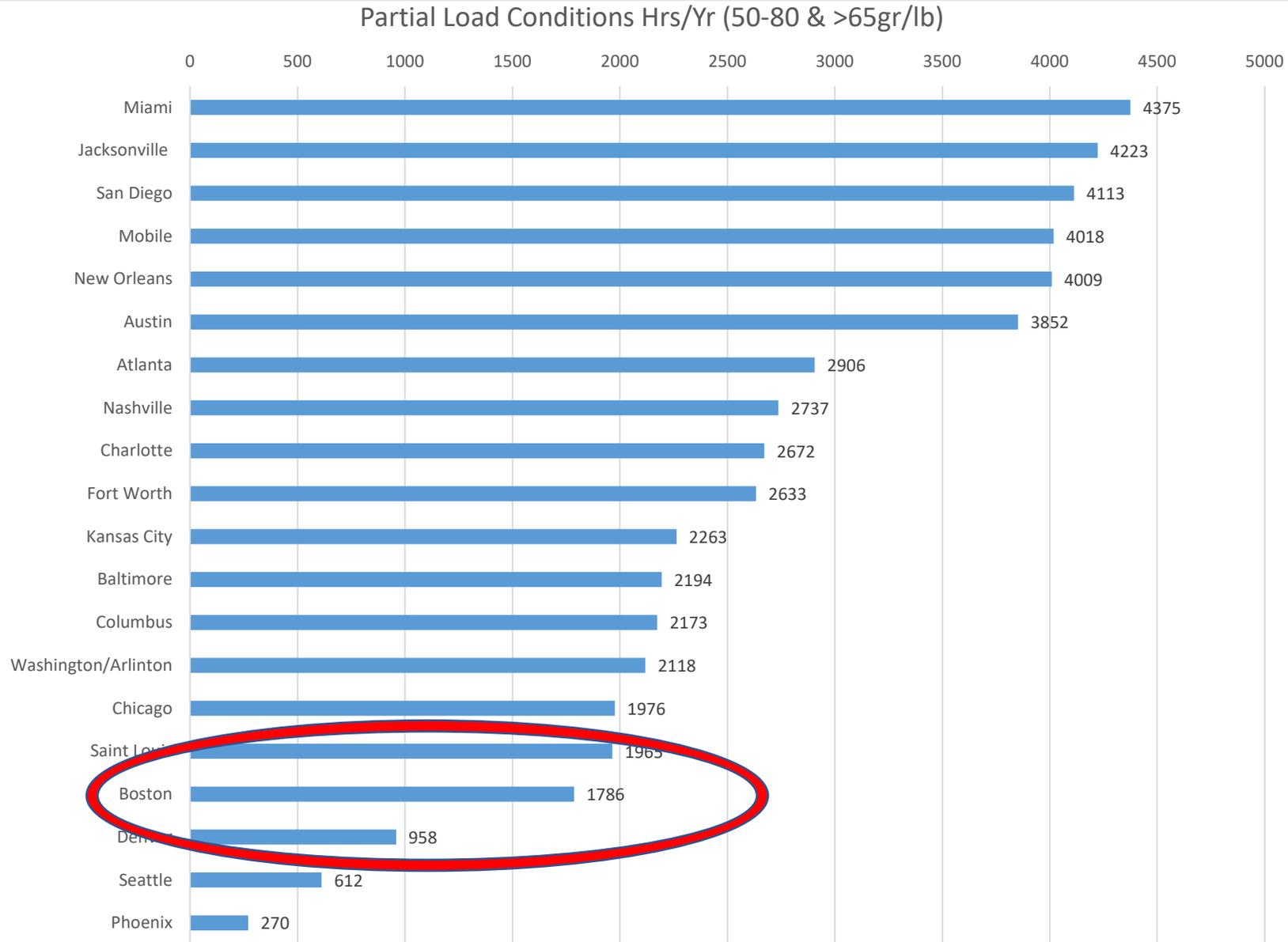
If you've been following this blog for a while, you probably know the pitfalls of an exhaust-only strategy. One of the main problems is that you don't know where the makeup air is coming from. For every cubic foot of air that gets exhausted through one of these fans, another cubic foot of air has to come into the house somewhere.



HVAC System

- Typically, the mechanical system is not focused solely on the basement
- As we build homes tighter or renovate to higher performance standards, the HVAC system runs less
- The more energy efficient the AC system the less water it removes
- Need runtime to remove water from the air
- Dedicated AC systems for basements will not control humidity and will make conditions worse

Humid Partial Load Annual Frequency





Variable Capacity Equipment

- Higher AVG Supply Air Temp (~60F – typical 55F)
- Typically, higher operational SHRs
- Less latent capacity when turned down
 - 3000 btuh Total ~2000 btuh Sensible & 1000 btuh Latent

Sensible Heat Ratio

Sensible Heat Ratio (SHR)- The dehumidification effectiveness of air conditioning equipment

$$\text{SHR} = \frac{\text{Sensible Cooling Load}}{\text{Total Cooling Load}}$$

SHR of Equipment

Rated Cooling Capacity (Btu/h) [95F]	SEER	Sensible Heat Factor
18000	20.5	0.87
22400	20.5	0.75
30600	14.5	0.64
33200	14.5	0.62
6000	33.1	0.96
6000	33.1	0.96
9000	30.5	0.92
9000	30.5	0.92
12000	26.1	0.83



Dehumidification

- Dehumidifier is the only solution that can keep the space to a set RH
 - Key is removal, not dilution
- 

Dehumidifier Operation

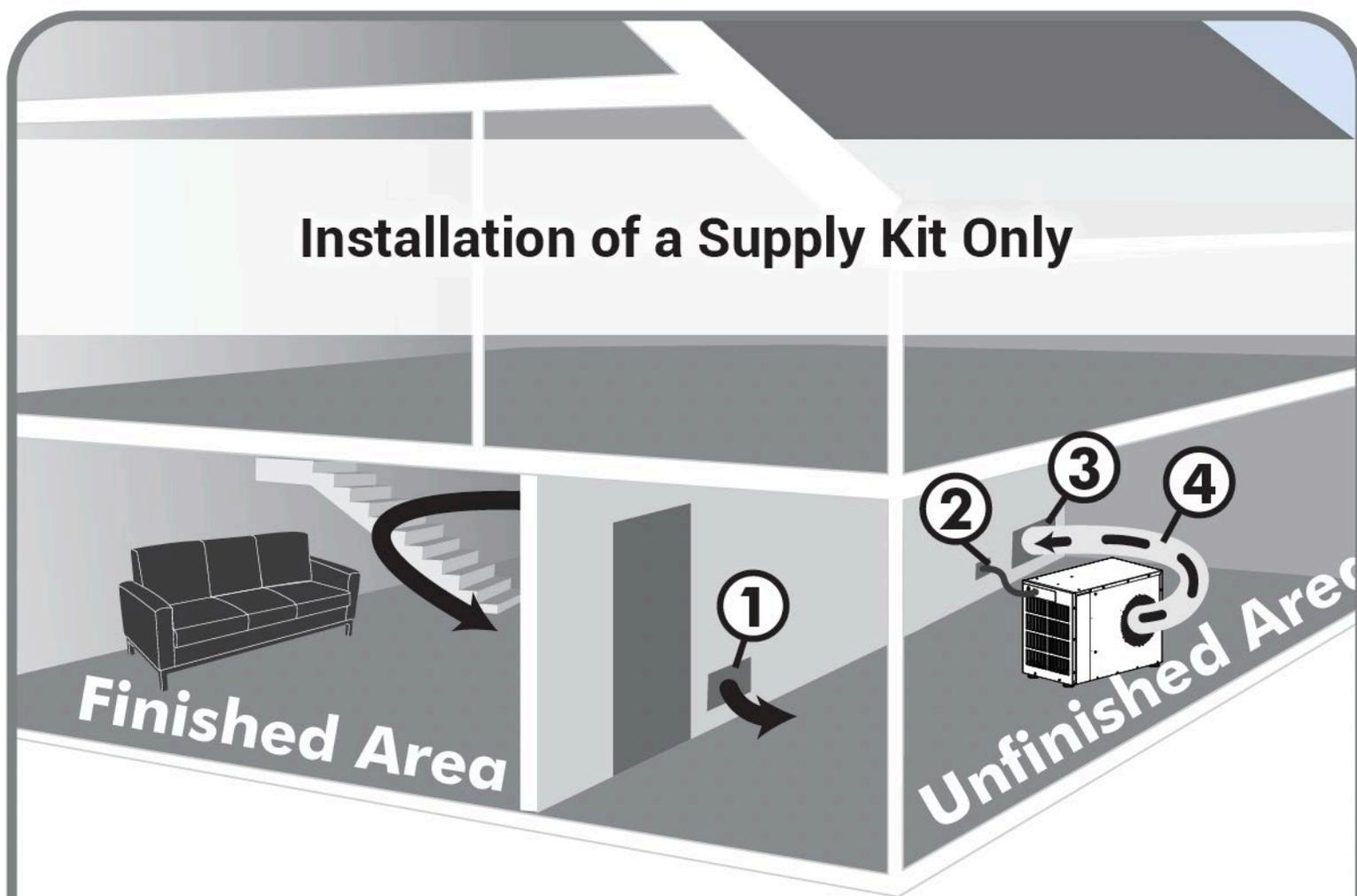
- Set dehumidifier to run at 50-55% RH
- Keeps outlying areas of basement from exceeding 60% RH
- Really no benefit in setting dehumidifier below 50% - increases operation cost



Dehumidifier Air Movement - Ducting

- Dramatically reduces dehumidifier short cycling and dry zones around dehumidifier.
 - Helps distribute dry air throughout space
-

Installation of a Supply Kit Only



① Passive Return Vent

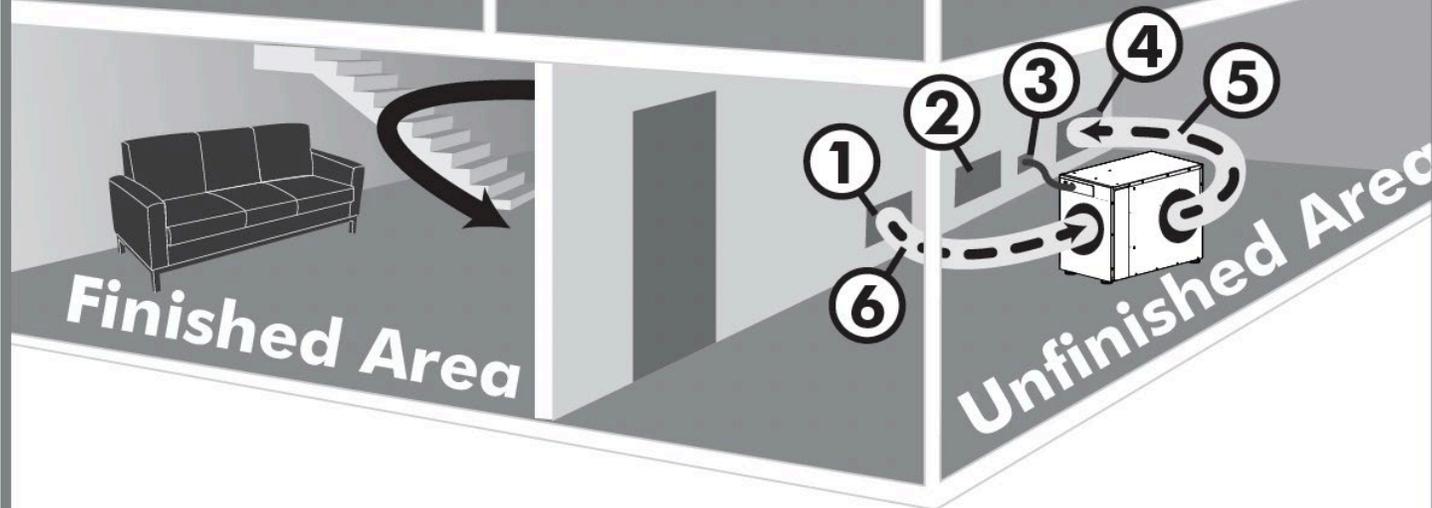
③ Supply Grill

② Optional Wall
Mount Dehumidistat

④ Supply/Discharge
Duct Work

(mounts on opposite wall in finished area)

Installation of a Supply and Return Duct Kit



① Return Grill

② Passive Return Vent*

③ Optional Wall Mount
Dehumidistat (mounts on
opposite wall in finished area)

④ Supply Grill

⑤ Supply/Discharge
Duct Work

⑥ Return/Intake
Duct Work

Dehumidifier Air Movement

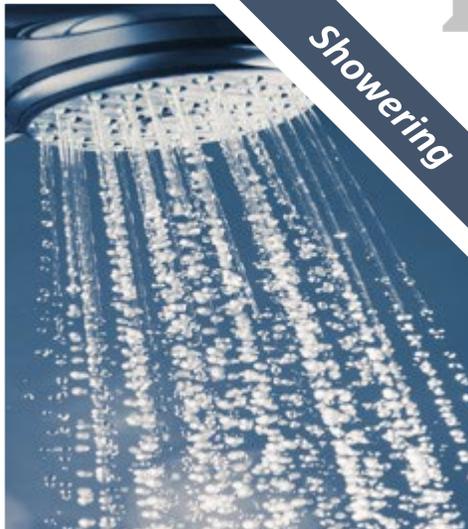


How to Size Dehumidifiers

- What is the space being used for?
- What is contributing to the moisture load?
- Are there people in the home with health problems?
- Most common – square footage recommendations by manufacturer – be careful!

It is easy to undersize a dehumidifier but hard to oversize.

Occupant Behavior



One person adds about $\frac{1}{4}$ pound of moisture from breathing plus $\frac{1}{4}$ pound from activities to a home per hour.



4 occupants add 2 pounds (14,000 grains) of moisture to a home per hour.



BIG BOX STORE DEHUMIDIFIERS VS. COMMERCIAL GRADE

- Do not have auto restart when electricity goes out
- 1-2 year warranty vs a 6-year
- Capacities greatly reduced in cooler environments
- Millions recalled in the last several years due to fires
- Avoid units with built in condensate pumps – not a matter if it will fail – it is a matter of when
- Can not be ducted – create micro-climates
- Very minimal filtration vs MERV 13
- Most made overseas



Dehumidification Capacity Ratings

- Dehumidifiers use to rated @
80F/60%RH – 0.0 IWG (AHAM)
- New 2019 DOE – 65F/60%RH – 0.0 IWG

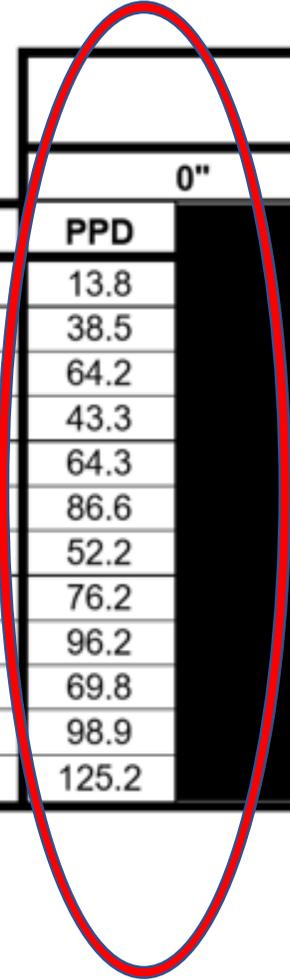
Dehumidifier Performance

Higher Static Lower Removal



		Static Pressure									
		0"		0.2"		0.4"		0.6"		0.8"	
TEMP	RH	PPD		PPD		PPD		PPD		PPD	
60	40%	13.8		5.2		4.4		3		0	
60	50%	38.5		33.8		26.3		19.8		-4.4	
60	60%	64.2		62		54		57.4		49.8	
65	40%	43.3		36.5		33.1		32		19.1	
65	50%	64.3		64.2		62.6		52		48.5	
65	60%	86.6		85.1		81.5		80.2		68.2	
70	40%	52.2		52.2		52.3		42.7		43.6	
70	50%	76.2		73.7		71.1		69.5		67.3	
70	60%	96.2		96.2		91.1		91.3		82.8	
80	40%	69.8		70		68.5		67.6		67	
80	50%	98.9		100.5		94.7		94		87.7	
80	60%	125.2		126		121		118		109.4	

Less Moisture
Lower Removal





Dehumidifier Sizing

- Most Basements : Santa Fe Classic
- For Very Large or Wet Basements: Santa Fe 155
- For Highest Energy Efficiency: Santa Fe Oasis105
- For Small Basements: Santa Fe Compact70 or MD33

MD33 In-Wall Dehumidifier



- 33 Pints/Day
- 2.8 AMPS, 120 volt
- 2.0 L/kWh
- 155 CFM
- 1,200 Sq. Ft. of Coverage
- Washable Filter







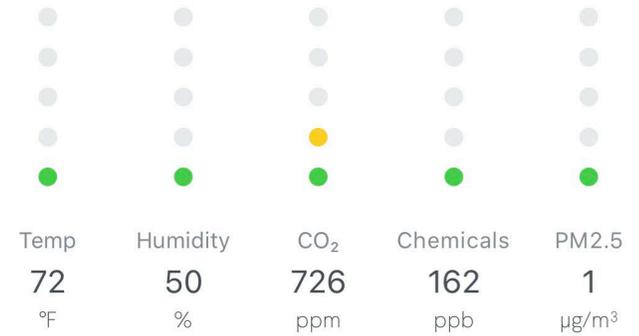


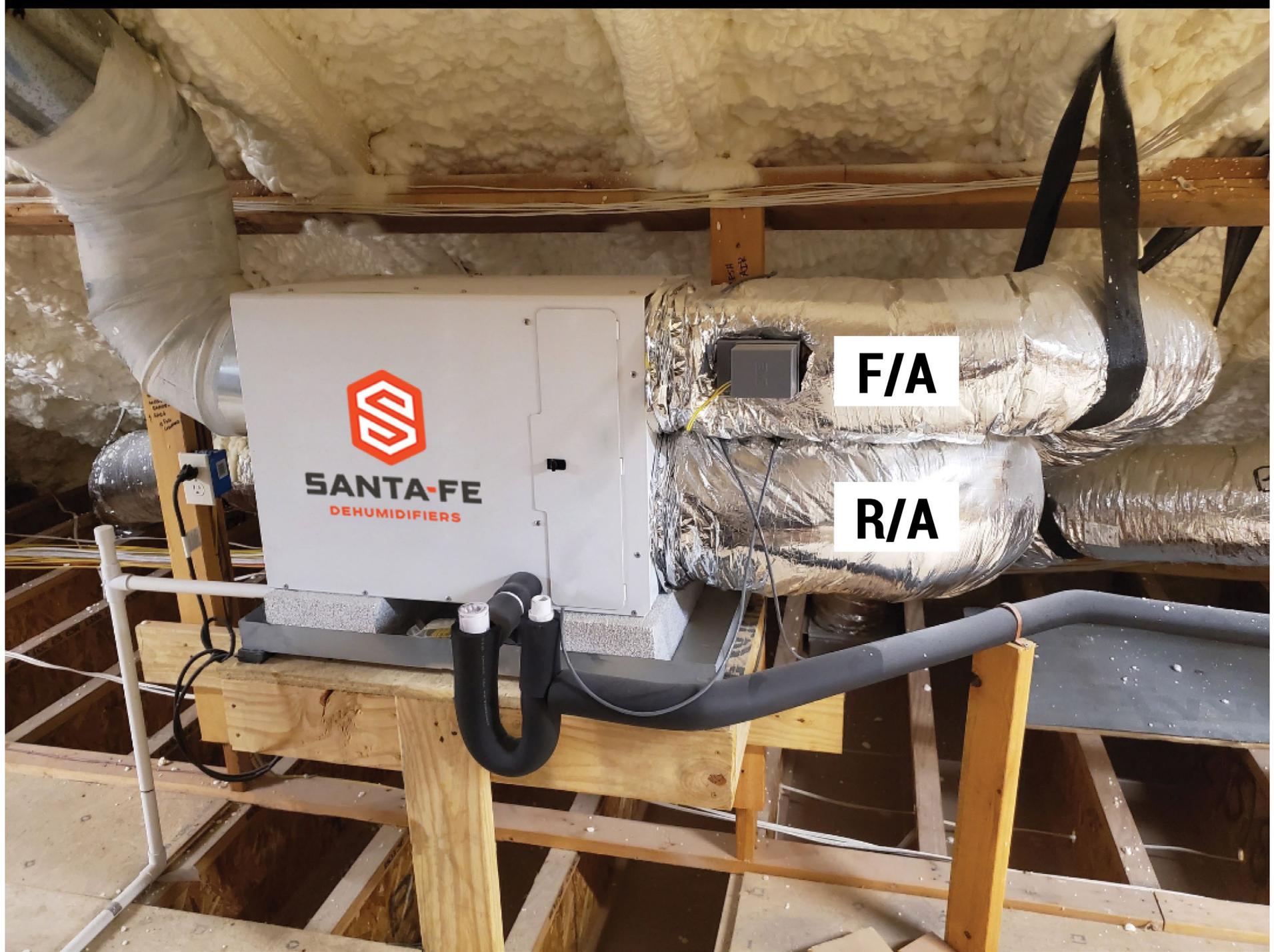
Oais105 OVERVIEW

- Stand-Alone or ducted on the HVAC System
- On-board digital controls
- Terminal block for remote control
- Dew point cut-out control
- Variable-speed fan
- Integrated secondary drain pan with dedicated float switch port
- Positive pressure drain
- Molded base with integrated handles
- MERV 13 filter



Monitoring





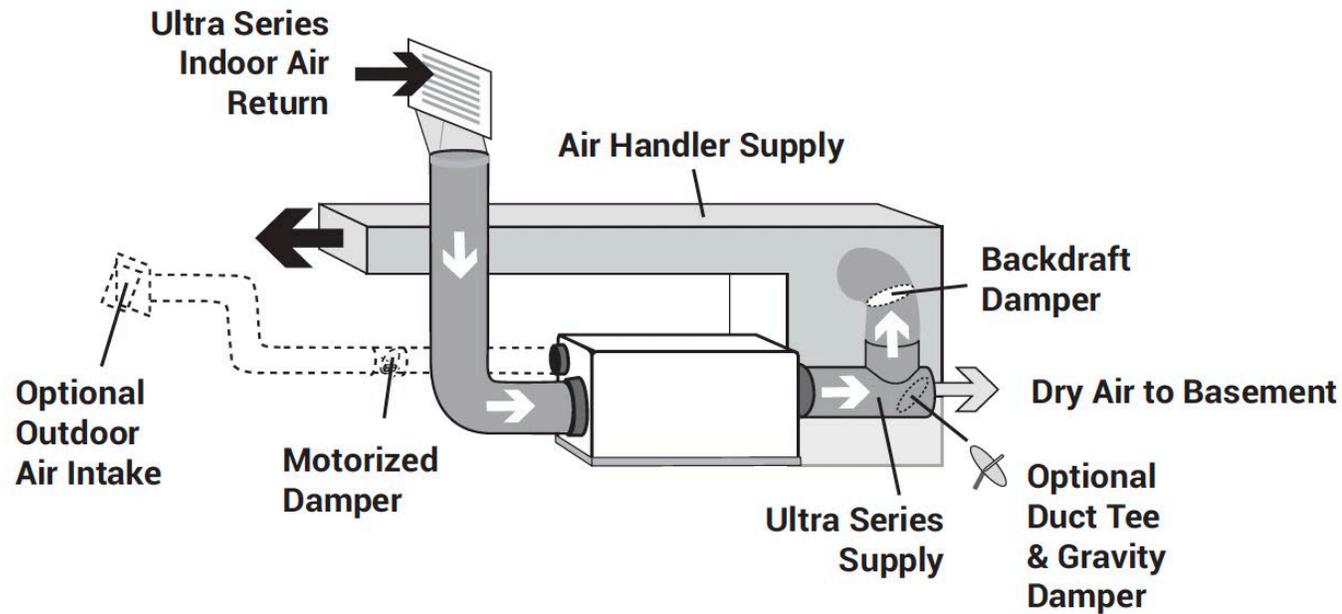
F/A

R/A

b. Installation in a Basement or Crawlspace

Install a separate 8" return for the Ultra98/120 in a central area of the structure. Duct the supply of the dehumidifier to the air supply of the HVAC system with a backdraft damper.

Optional: Duct the supply of the Ultra98/120 to a 8" x 8" x 8" tee/damper with a gravity draft damper, adjusted to 20% open to the basement. CAUTION: Air takes the path of least resistance. If the upper levels of the living space are not receiving the appropriate amount of dry air, this damper may need to be adjusted. When the dehumidifier is not running, there is a chance that air from the basement or crawlspace will make its way back through the gravity damper and into the living space.



In The Words Of Dr. Joe

“You cannot energy conserve your way to dry.”



Ventilation Electrical Usage

Reset

Print



Power rating [**W**] 580

Days per year in use 180

Hours per day in use 24

Minutes per hour in use 20

Avg cost per kWh 0.21

Annual usage time [**hr**] = 1440

Annual electrical usage [**kWh**] = 835

Annual electrical cost = 175

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Opportunity

	Number of housing units (million)						
	Total U.S. ²	Northeast Census Region		Midwest Census Region			
		Total Northeast	New England	Middle Atlantic	Total Midwest	East North Central	West North Central
All homes	118.2	21.0	5.6	15.4	26.4	18.1	8.3
Dehumidifiers and usage							
Have a dehumidifier	16.7	5.4	1.6	3.8	6.9	5.1	1.9
Do not use	0.4	Q	Q	Q	0.3	Q	Q
Used less than 4 months	5.5	2.1	0.8	1.3	2.1	1.7	0.5
Used 4 to 6 months	6.5	1.7	0.5	1.2	3.2	2.2	0.9
Used 7 to 9 months	2.0	0.7	Q	0.6	0.7	0.5	0.2
Used 10 to 11 months	Q	Q	Q	Q	Q	Q	Q
Turned on all 12 months	2.1	0.7	Q	0.6	0.7	0.5	0.2
Do not have a dehumidifier	101.5	15.6	4.0	11.6	19.4	13.0	6.4

Source: U.S. Energy Information Administration - Residential Energy Consumption Survey



Homeowner Benefits

A Healthier and Happier Home

- Better air quality in the basement, which means better air quality in the living space
- Leads to a reduction in adverse health effects such as upper respiratory problems and asthma symptoms
- Protects against damage to the home such as mold, cupping of wood floors, and wood rot
- Greater comfort in the home because of reduced humidity
- Fewer pest and critter problems
- Improved relationship with their contractor



Building Science Crawl Space Encapsulation Class



Crawl Space
Encapsulation
Specialist

This 2-day course offers you the building science knowledge you need to successfully encapsulate a crawl space and expand your profit-making opportunities.

Program details include:

- *Psychrometry and moisture science*
- *Mold prevention*
- *Engineered moisture control*
- *Effects of moisture content on building materials*
- *Building and energy codes governing encapsulation installations*
- *Encapsulation principles*
- *Categorization of crawl spaces based on energy, moisture and health management*
- *Dehumidifier sizing, installation and control*
- *Standardized step-by-step processes for moisture blocking and removal*

This course is taught through a combination of classroom lecture and hands-on in a mock crawl space. An exam follows to complete the training process.