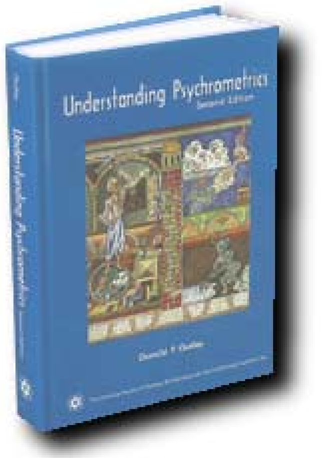
Controlling Indoor Humidity in High Performance Homes

Danny Gough, Energy Solutions, LP

Taking care of business

Fundamentals

What’s in Air?

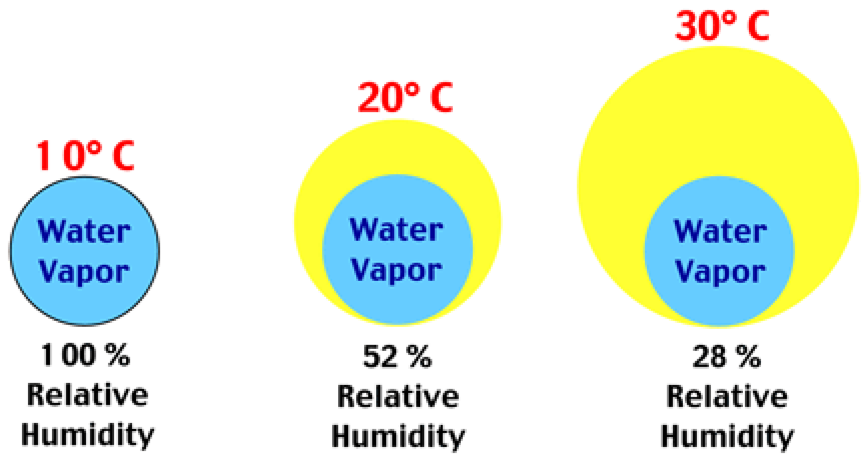


Nitrogen 78.08
Oxygen 20.95
Argon 0.93
Carbon dioxide 0.03
Neon 0.0018
Helium 0.0005
Krypton 0.0001
Xenon 0.00001

And Water Vapor

How much water vapor air can hold is relative to its temperature.

Hence – “relative humidity”



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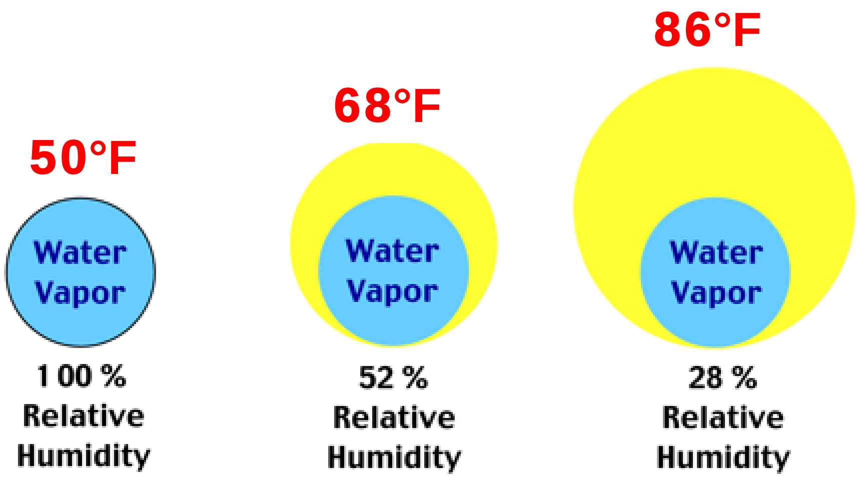


IP Version

DEW POINT

The temperature at which air become saturated and water vapor changes from a gas into a liquid.

Why is humidity control important ?

Because it can affect

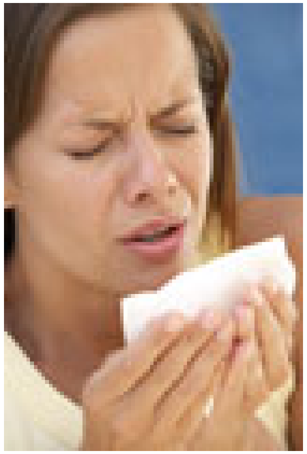
1. Health
2. Durability
3. Comfort
4. Energy Efficiency

Health

Humidity may not be a pollutant, but it can certainly be a indicator for potential indoor air quality problems.

Health Problems with Low Humidity RH < 35%

- Dry sinuses,
- nose bleeds,
- bronchitis,
- sinusitis,
- dehydration (dry skin)
- skin irritation
- itchy eyes,
- increases the spread of bacteria and viruses.

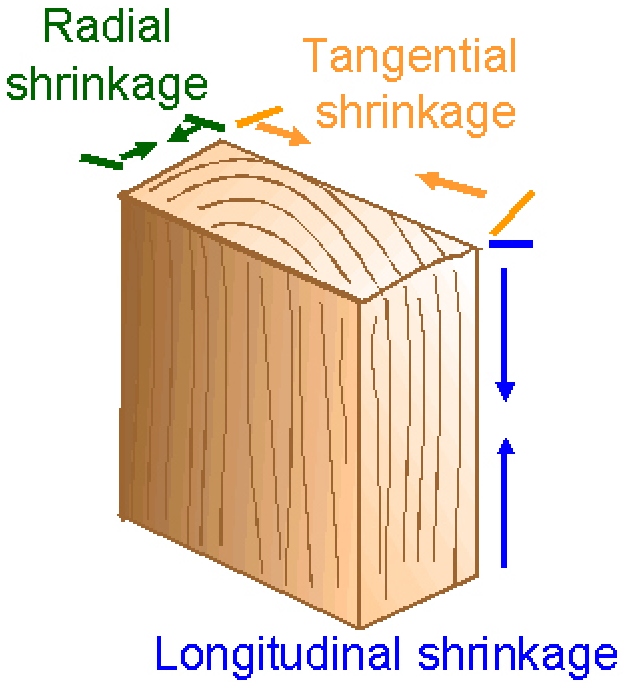


Health Problems with High Humidity RH > 50%

- Dust mites - RH > 55%,
- Interior mold - RH > 70%
- Increased off-gassing of VOC's
- (10% RH increase x 2)

Durability Problems with uncontrolled humidity

- Wood changes dimension with changes in its moisture content.



Durability Problems with uncontrolled humidity

The moisture content of wood is directly related to the humidity and temperature of the surrounding air.

The higher the RH, the higher the moisture content of exposed wood.

Durability Problems with uncontrolled humidity

- The Equilibrium Moisture Content (EMC) is the moisture content that wood will try to attain under specific conditions of relative humidity and temperature.

- EMC can be used to predict the RH of ambient air and vice versa.

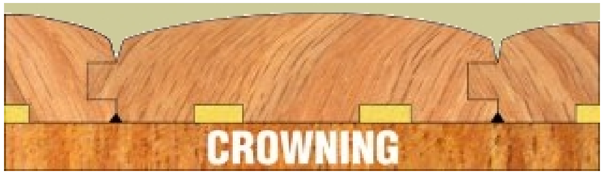
Durability Problems with low humidity - RH< 35%

- At Low Humidity wood shrinks
- Creates gaps in hardwood floors
- Moldings separate requiring caulking and repainting.
- Shrinking wood pulls away from joints.
- Potential of structural compromise.

Durability Problems with high humidity - RH >50%

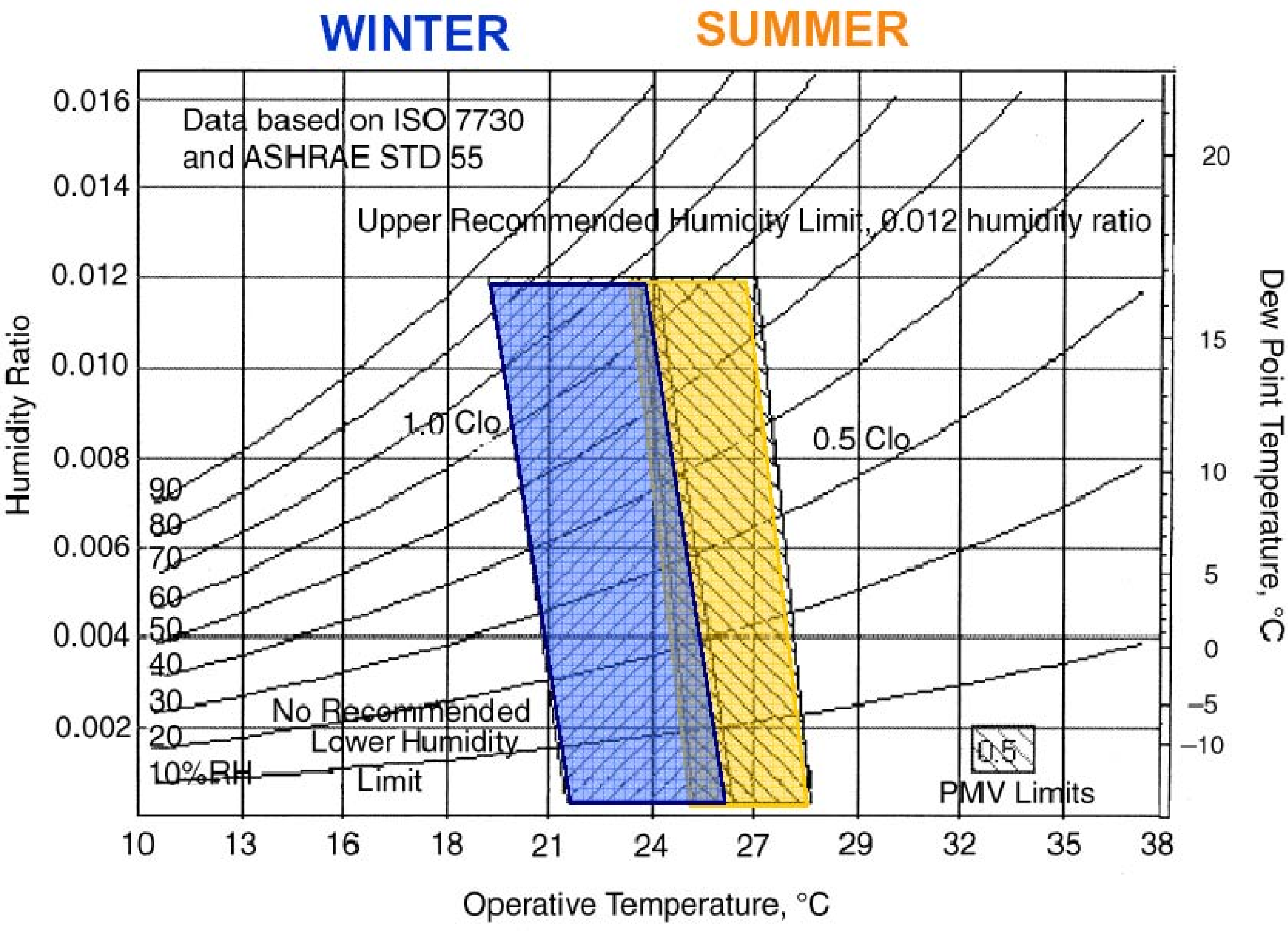
At high humidity wood expands- Hardwood floors crown or cup. Require refinishing and repainting.

Equilibrium moisture content of 90% = MC above 20%



Wood may start to decay above 20% MC

Humidity affects Comfort
(ASHRAE Std 55-2004)



Comfort Problems with lower humidity

Relative Humidity	Acceptable Range for Comfort
RH = 30 %	69°- 78° F
RH = 60 %	68°- 75° F

*Low humidity = aggravating static electricity. You get shocked from almost everything you touch

Comfort Problems with higher humidity

Relative Humidity	Acceptable Range for Comfort
RH = 30 %	76°- 82° F
RH = 60 %	74°- 78° F

It's not the heat, it's the humidity

Comfort Problems with higher humidity

HEAT INDEX TABLE

Relative Humidity

AIR TEMPERATURE

	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
76°		60°	63°	67°	70°	73°	76°	79°	82°	85°
78°		63°	67°	70°	74°	76°	79°	82°	85°	89°
80°	62°	66°	70°	73°	77°	80°	83°	86°	90°	93°
82°	63°	68°	73°	76°	80°	83°	86°	90°	93°	97°
84°	66°	71°	76°	79°	83°	86°	90°	94°	98°	103°
86°	68°	73°	78°	82°	86°	90°	94°	98°	103°	
88°	70°	76°	81°	85	89°	93°	98°	102°	108°	
90°	73°	78°	84°	88°	93°	97°	102°	108°		
92°	75°	82°	87°	91°	96°	101°	106°	112°		
94°	77°	84°	90°	95°	100°	107°	111°			
96°	79°	87°	93°	98°	103°	110°	116°			
98°	82°	90°	96°	101°	107°	114°				
100°	85°	92°	99°	105°	111°	118°				
102°	87°	95°	102°	108°	115°	123°				
104°	92°	98°	106°	112°	120°					

It's not the heat, it's the humidity

Energy Penalty of Uncontrolled Humidity

Low winter humidity requires higher thermostat set point to feel comfortable. Increasing ID temperature increases heating bills.

High summer humidity requires lower thermostat set point to achieve comfort. Lowered ID temperature increases cooling bills.

Removing humidity cost more than removing heat.

Where does unwanted “house” moisture come from

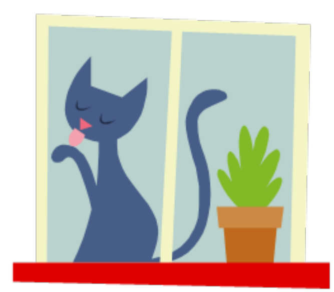
Sources from without –

1. The sky – rain
2. The ground - subsurface
3. The air – water vapor

Where does unwanted moisture come from

Sources from within –

1. People Breathing (2 gal/day*)
2. People Bathing
3. People Cooking
4. People Cleaning
5. People's Pets (Especially Fish)
6. Peoples Plants



* Family of 4

Solution to High Humidity

Get rid of the people

These guys are well on their way.

Where does unwanted moisture come from

Sources from within –

7. Duct Leaks
8. House leaks
9. House vented appliances
10. Wet crawls and basements
11. Plumbing leaks
12. Materials (paint, concrete et al)

<u>Controlling Humidity</u>

Keep moisture out

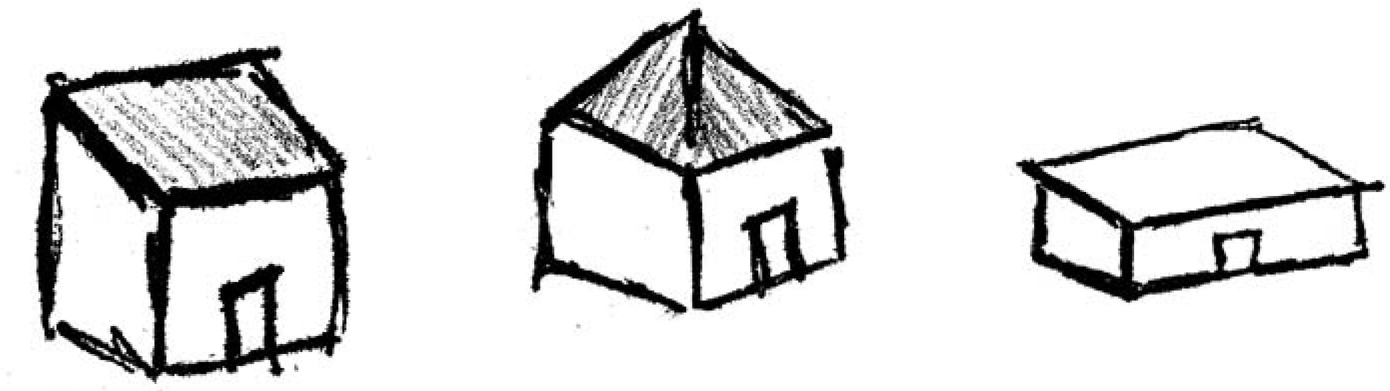
(preliminary requirements)

1. Sound roof geometry. Water flows down.
2. Use Overhangs. They protect the walls.
3. Drainage plane (use gravity instead of adhesives).
4. Flashing (ASTM E-2112).
5. Foundation water management.
6. Proper foundation drainage.
7. Proper downspouts.
8. Slope grade (direct your water to the neighbors lot).

Controlling Humidity

Keep moisture out

(preliminary requirements)



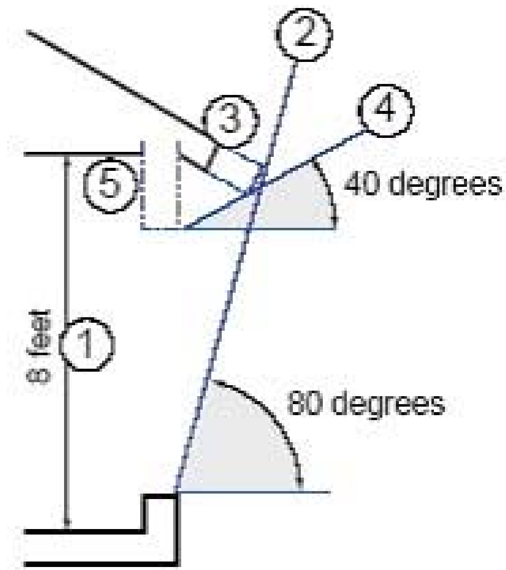
Good Better Not so good

Controlling Humidity

Keep moisture out

(preliminary requirements)

SIZE SOUTH-FACING OVERHANGS TO PROPERLY SHADE WINDOWS



Overhangs provide two benefits:

1. Protects the walls from elements
2. Can reduce solar gain if designed properly

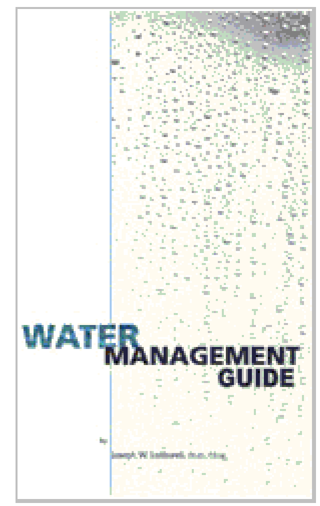
Controlling Humidity

Keep moisture out

(preliminary requirements)

ASTM E2112 Standard Practice for Installation of Exterior Windows, Doors and Skylights.

Learn how to do it right !



Controlling Humidity

Keep moisture out

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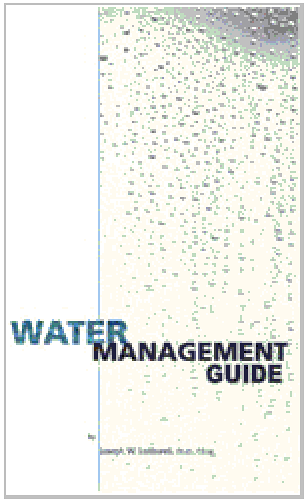


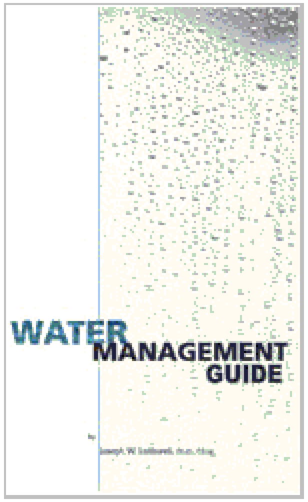
Controlling Humidity

Keep moisture out

(preliminary requirements)

Foundation water management

1. Formed footing with capillary break.
2. Perimeter drain installed below the top of the footing
3. Damp-proofing on the exterior wall.
4. Drainage mat - manipulates driving force, sends water to perimeter drain.
5. Proper backfill.
6. Grade away from house – use swales.
7. Pipe downspouts away.



Controlling Humidity

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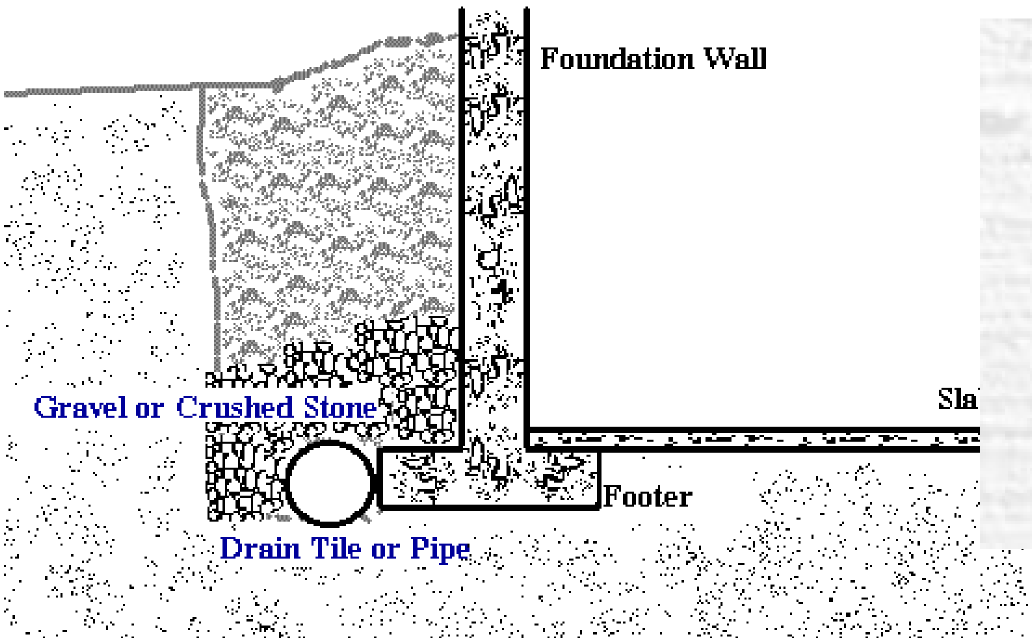
Foundation water management



Controlling Humidity

Keep moisture out

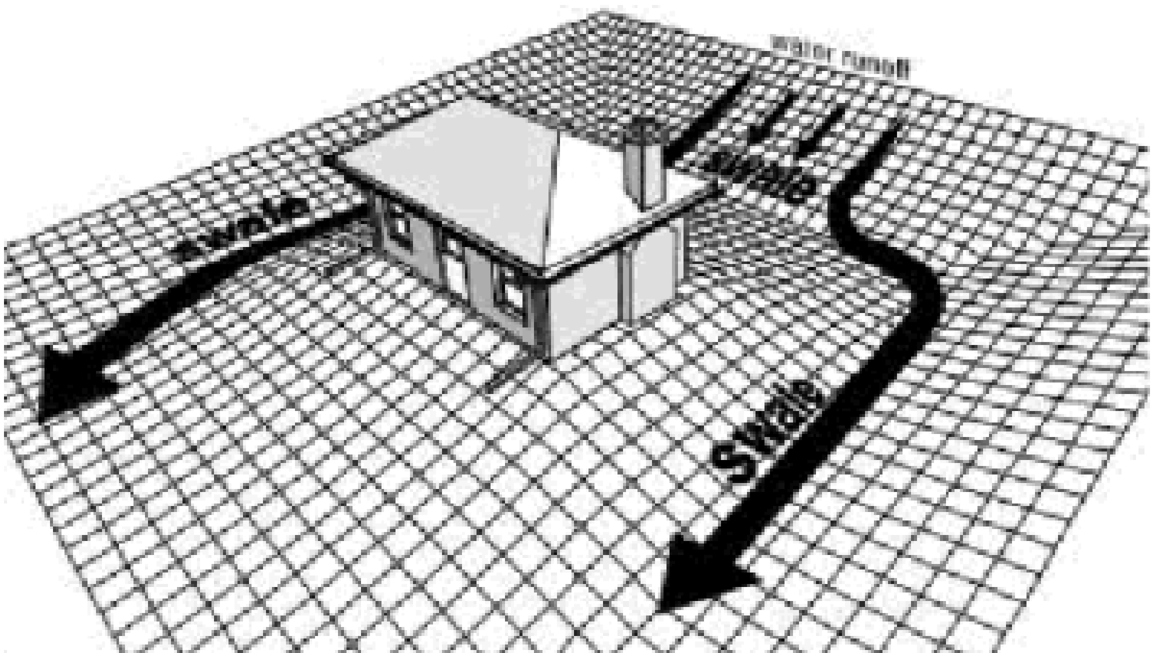
(preliminary requirements)

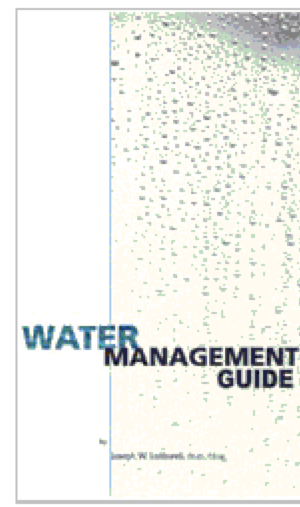
Foundation water management

<u>Controlling Humidity</u>

Keep moisture out
(preliminary requirements)

<u>Foundation water management</u>



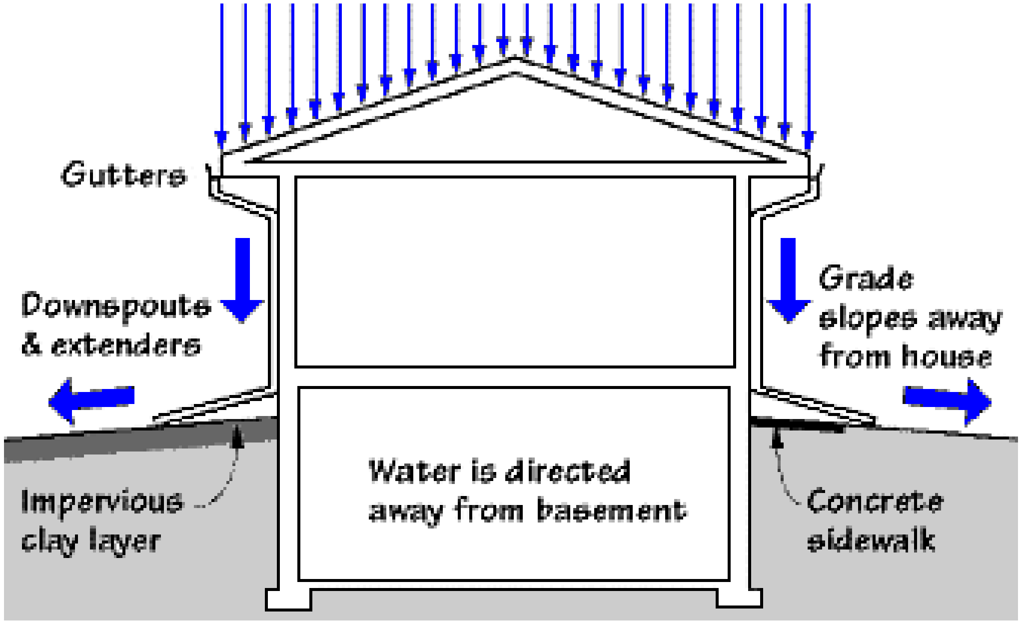


Controlling Humidity

Keep moisture out

(preliminary requirements)

Drain the rain



Controlling Indoor Moisture
(preliminary requirements)

Keep crawl space moisture at bay ?

Controlling Indoor Moisture

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Keep crawl space moisture at bay ?

Closed crawl space

Controlling Indoor Moisture
(preliminary requirements)

Keep crawl space moisture at bay ?

Closed crawl space

Controlling Indoor Moisture

(preliminary requirements)

Track indoor humidity levels.

Controlling Indoor Moisture

(preliminary requirements)

Remove bulk moisture from showers, tubs and cooking using properly fans ducted to the outside.

Controlling Indoor Moisture
(preliminary requirements)

- ✓ Size bath exhaust fans for 8 air changes per hour.
- ✓ Area x ceiling height x 8 / 60
- ✓ Verify performance by testing

EXHAUST FAN SIZING

Area of Bathroom Sq Ft (WxD)	CFM required w/ 8 ft ceiling	CFM required w/9 ft ceiling
50	53	60
60	64	72
70	75	84
80	85	96
90	96	108
100	107	120
110	117	132
120	128	144
130	139	156
140	149	168
150	160	180
160	171	192
170	181	204
180	192	216
190	203	228
200	213	240

Controlling Indoor Moisture

(preliminary requirements)

Why test ?

Controlling Indoor Moisture

(preliminary requirements)

Right size cooling equipment

small building applications

Dehumi

By **Don B. Shirey III,** Member ASHRAE, and **Hugh I. Henderson Jr., P.E.,** Member ASHRAE

Engineers and equipment manufacturers need a better understanding of dehumidification performance at part-load conditions to evaluate the impacts of their design choices on indoor humidity levels, occupant comfort, and indoor air quality. Data from previous field test studies[1,2] show that the moisture removal capacity of a cooling coil degrades at part-load conditions — especially when the supply air fan operates continuously.

Figure 1 illustrates this concept with transient data from a laboratory test. Degradation occurs because a portion of the moisture that condenses on the coil surfaces during the cooling on cycle (blue data) evaporates back into the airstream when the coil is off (green data). The data in the plot shows that the transient off-cycle performance of the coil is essentially adiabatic with sensible cooling (red data) provided in conjunction with evaporation of moisture (green data) back into the airstream. The off-cycle sensible cooling diminishes with time as the amount of available moisture on the coil surfaces decreases. As a result, a cooling coil that cycles on and off in response to a control or thermostat signal will provide a smaller fraction of its total cooling capacity as moisture removal when the system spends relatively more time with the coil off. Conversely, the full latent removal capability of the system is only realized when the coil operates continuously.

The net impact of this latent degradation phenomenon is that dehumidification performance depends on the runtime fraction of the cooling coil (load divided by steady-state capacity). *Fig-*

About the Authors

Don B. Shirey III is principal research engineer at the Florida Solar Energy Center in Cocoa, Fla. **Hugh I. Henderson Jr., P.E.,** is a principal with CDH Energy in Cazenovia, N.Y.

- Research by Shirley and Henderson, published in Ashrae Journal-April 2004 showed:
- High efficiency air conditioners require 9 to 29 minutes to reach steady state efficiency.
- Fan delay increase RH.

Controlling Indoor Moisture

(preliminary requirements)

Right size cooling equipment

	Cooling Capacity	Fin Surface Area	Moisture-Holding Capacity, M_o		Cond. Delay Time, t_o	t_{wet}
	tons (kW)	ft² (m²)	lb (kg)	lb/1,000 ft² (g/m²)	Min	Min
Coil 1 (Slanted Slab, Three Rows, 13 fpi, Plain Fins, Orifice)	3.0 (10.5)	243.8 (22.7)	2.1 (0.95)	8.6 (42.1)	13.5	16.5
Coil 2 – Normal Air Flow Rate (A-coil, Three Rows, 15.5 fpi, Lanced Sine-Wave Fins, TXV)	2.4 (8.4)	237.8 (22.1)	2.0 (0.91)	8.4 (41.1)	16.3	17.0
Coil 3 – Coil 2 with Low Airflow (A-Coil, Three rows, 15.5 fpi, Lanced Sine-Wave Fins, TXV)	1.5 (5.3)	237.8 (22.1)	2.0 (0.91)	8.4 (41.1)	32.5	29.0
Coil 4 (Vert. Slab, Two rows, 14 fpi, Wavy Fins, Orifice)	1.8 (6.3)	138.3 (12.8)	1.9 (0.86)	13.7 (67.0)	23.5	18.5
Coil 5 (Slanted Slab, Four Rows, 12 fpi, Wavy Fins, Orifice)	2.3 (8.1)	162.7 (15.1)	1.4 (0.64)	8.6 (42.1)	11.5	9.0

Notes:
1. Cooling capacity includes sensible and latent cooling at nominal conditions with airflow rate of 400 cfm/ton (54 L/s per kW). Nominal conditions correspond to ASHRAE Test A test point.
2. Fin surface area is gross fin area (coil face area × coil depth × fin spacing × 2).
3. Condensate delay time and t_{wet} are at nominal conditions.

Table 1: Comparing measured performance parameters for lab-tested cooling coils.

Controlling Indoor Moisture

(preliminary requirements)

Right size cooling equipment

Perform aggressive Manual J load calculations on every home.

- Do not add safety factors.
- Do not design for record breaking temperatures
- Do not add internal loads for entertaining groups of people.

Controlling Indoor Moisture

(preliminary requirements)

Right size cooling equipment

- Review equipment product data
- Adjust equipment performance for design conditions (75/63)
- Select equipment to meet both sensible and latent loads
- Total gain is irrelevant

Performance Data ARI Standard Conditions—RPPL- JEZ

Note: Only these combinations of indoor/outdoor units are approved and any other combinations should not be used.

Model Numbers		ARI Cooling Performance 80°F [26.5°C] DB/67°F [19.5°C] WB Indoor Air 95°F [35°C] DB Outdoor Air							ARI Heating Performance (70°F [21°C] Indoor) Outdoor Air 47°F [8.5°C] DB/ 43°F [6°C] WB DOE High Temp.		ARI Heating Performance Outdoor Air 17°F [−8.5°C] DB/ 15°F [−9.5°C] WB DOE Low Temp.		DOE Region IV HSPF
Outdoor Unit RPPL-	Indoor Coil and/or Air Handler	Total Capacity BTU/H [kW]	Net Sens. BTU/H [kW]	Net Latent BTU/H [kW]	EER	SEER	Snd. Rate dB	Indoor CFM [L/s]	BTU/H [kW]	COP	BTU/H [kW]	COP	
018JEZ	RHLL-HM2417 (RCSL-H*2417A*) ①	18,800 [5.5]	14,150 [4.1]	4,650 [1.4]	12.00	14.00	72	600 [283]	17,700 [5.2]	3.80	11,100 [3.3]	2.52	9.00
	RCFL-H*2414A*	18,300 [5.4]	13,650 [4.0]	4,650 [1.4]	10.65	13.00	72	600 [283]	18,200 [5.3]	3.54	11,600 [3.4]	2.40	8.50
	RCFL-H*2417A*	18,300 [5.4]	13,650 [4.0]	4,650 [1.4]	10.65	13.00	72	600 [283]	18,200 [5.3]	3.54	11,600 [3.4]	2.40	8.50
	RCFL-H*2417A* (RGFD-06?MCK?)	18,700 [5.5]	14,050 [4.1]	4,650 [1.4]	11.75	14.00	72	600 [283]	17,700 [5.2]	3.78	11,100 [3.3]	2.54	9.00
	RCFL-H*2417A* (RGFD-07?MCK?)	18,700 [5.5]	14,050 [4.1]	4,650 [1.4]	11.75	14.00	72	600 [283]	17,700 [5.2]	3.79	11,100 [3.3]	2.54	9.00
	RCFL-H*2417A* (RGGD-06?MCK?)	18,800 [5.5]	14,150 [4.1]	4,650 [1.4]	12.00	14.00	72	600 [283]	17,700 [5.2]	3.81	11,100 [3.3]	2.56	9.00
	RCFL-H*2417A* (RGGD-07?MCK?)	18,800 [5.5]	14,150 [4.1]	4,650 [1.4]	11.80	14.00	72	625 [295]	17,700 [5.2]	3.80	11,100 [3.3]	2.55	9.00
	RCFL-H*2417A* (RGJD-06?MCK?)	18,800 [5.5]	14,150 [4.1]	4,650 [1.4]	12.00	14.00	72	600 [283]	17,700 [5.2]	3.81	11,100 [3.3]	2.56	9.00
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	RCFL-H*2417A* (RGLR-07?AMK?)	18,800 [5.5]	14,150 [4.1]	4,650 [1.4]	12.00	14.00	72	600 [283]	17,600 [5.2]	3.82	11,100 [3.3]	2.56	9.00
	RCFL-H*2417A* (RGPR-05?BMK?)	18,700 [5.5]	14,050 [4.1]	4,650 [1.4]	11.65	14.00	72	600 [283]	17,700 [5.2]	3.77	11,100 [3.3]	2.53	9.00
	RCFL-H*2417A* (RGPR-07?AMK?)	18,800 [5.5]	14,150 [4.1]	4,650 [1.4]	12.00	14.00	72	600 [283]	17,700 [5.2]	3.81	11,100 [3.3]	2.55	9.00
	17AHLL24HM (RCSL-H*2417A*)	18,800 [5.5]	14,150 [4.1]	4,650 [1.4]	12.00	14.00	72	600 [283]	17,700 [5.2]	3.80	11,100 [3.3]	2.52	9.00
	17AHSL18HM (RCSL-H*2417A*)	18,500 [5.4]	13,950 [4.1]	4,550 [1.3]	11.05	13.00	72	600 [283]	18,000 [5.3]	3.60	11,400 [3.3]	2.43	8.50
	RHKL-HM2417 (RCSL-H*2417A*)	19,000 [5.6]	14,450 [4.2]	4,550 [1.3]	12.00	14.00	72	650 [307]	17,700 [5.2]	3.80	11,100 [3.3]	2.55	9.00
	RHSL-HM1817 (RCSL-H*2417A*)	18,500 [5.4]	13,950 [4.1]	4,550 [1.3]	11.05	13.00	72	600 [283]	18,000 [5.3]	3.60	11,400 [3.3]	2.43	8.50
024JEZ	RHLL-HM2417 (RCSL-H*2417A*) ①	24,200 [7.1]	17,700 [5.2]	6,500 [1.9]	12.15	14.00	72	775 [366]	22,600 [6.6]	3.82	14,200 [4.2]	2.57	9.00
	RCFL-H*2414A*	23,600 [6.9]	17,100 [5.0]	6,500 [1.9]	11.05	13.00	72	775 [366]	23,200 [6.8]	3.60	14,700 [4.3]	2.43	8.50
	RCFL-H*2417A*	23,600 [6.9]	17,100 [5.0]	6,500 [1.9]	11.05	13.00	72	775 [366]	23,200 [6.8]	3.60	14,700 [4.3]	2.43	8.50
	RCFL-H*2417A* (RGFD-06?MCK?)	24,000 [7.0]	17,550 [5.1]	6,450 [1.9]	11.65	13.50	72	800 [378]	22,800 [6.7]	3.75	14,400 [4.2]	2.52	9.00
	RCFL-H*2417A* (RGFD-07?MCK?)	24,200 [7.1]	17,650 [5.2]	6,550 [1.9]	12.00	14.00	72	800 [378]	22,600 [6.6]	3.82	14,200 [4.2]	2.57	9.00
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	RCFL-H*2417A* (RGGD-07?MCK?)	24,000 [7.0]	17,600 [5.2]	6,400 [1.9]	11.85	14.00	72	800 [378]	22,600 [6.6]	3.79	14,300 [4.2]	2.55	9.00
	RCFL-H*2417A* (RGJD-06?MCK?)	24,000 [7.0]	17,600 [5.2]	6,400 [1.9]	11.90	14.00	72	800 [378]	22,600 [6.6]	3.81	14,200 [4.2]	2.56	9.00
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	RCFL-H*2417A* (RGLR-07?AMK?)	24,200 [7.1]	17,650 [5.2]	6,550 [1.9]	12.10	14.00	72	800 [378]	22,600 [6.6]	3.84	14,200 [4.2]	2.58	9.00
	RCFL-H*2417A* (RGPR-05?BMK?)	24,000 [7.0]	17,550 [5.1]	6,450 [1.9]	11.75	14.00	72	775 [366]	22,800 [6.7]	3.77	14,300 [4.2]	2.54	9.00
	RCFL-H*2417A* (RGPR-07?AMK?)	24,200 [7.1]	17,650 [5.2]	6,550 [1.9]	12.00	14.00	72	800 [378]	22,600 [6.6]	3.82	14,200 [4.2]	2.57	9.00

① Highest sales volume tested combination required by DOE test procedures.

[ ] Designates Metric Conversions

Controlling Indoor Moisture

(preliminary requirements)

Right size cooling equipment

Acme 1 ½ ton with super good air handler @ 650 CFM

	Load	Equip @ 75/63
Sensible Gain	14,530 btuh	14,700 btuh
Latent Gain	5,014 btuh	5,400 btuh
Net Gain	19,544 btuh	20,100 btuh

Controlling Indoor Moisture

(preliminary requirements)

Air Tight Ducts

Return leaks - pull unwanted moisture into duct system.

Supply leaks - create negative house pressure pulls unwanted moisture through house leaks.

Controlling Indoor Moisture

(preliminary requirements)

Pressure balancing

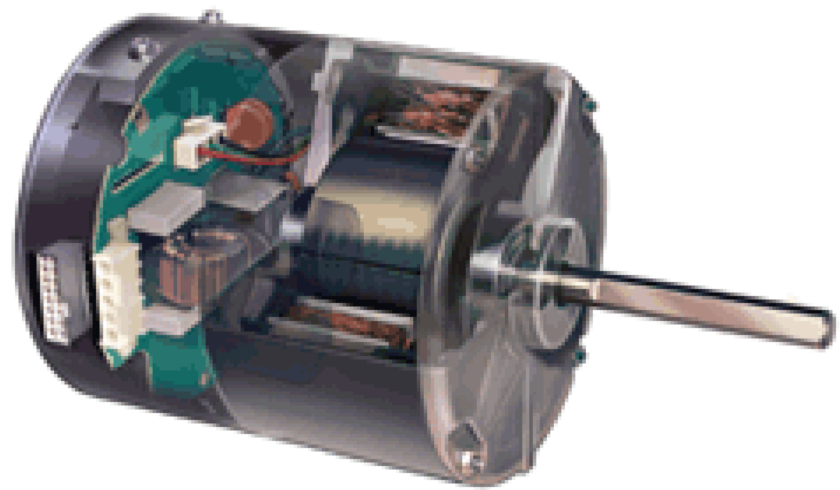
Provide a low resistance path between every isolated room and the closest return air opening. ACCA Manual D Section 1-4

Controlling Indoor Moisture

(preliminary requirements)

Use ECM blower motors

- Use less energy
- Adjust speed to deliver programmed airflow in duct systems (up to 1” WC)
- Fan speed can be manipulated for better humidity control



Controlling Indoor Moisture

(preliminary requirements)

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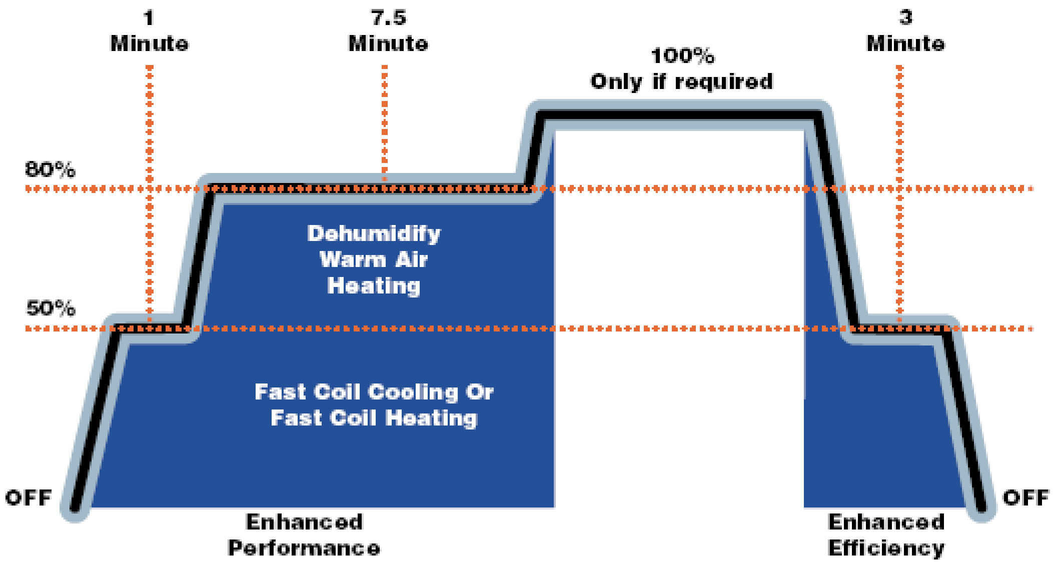


Controlling Indoor Moisture

Strategy 1 – Slow indoor blower speed

Most manufacturers provide a dehumidification mode through control circuitry which reduces the speed of the ECM motor 20%.

Controlling Indoor Moisture

38% Greater Latent Capacity

ODT = 95ºF - IDT = 95ºF – IWB = 95ºF 50% RH

	@900 cfm	@700 cfm
Sensible Gain	20,230 btuh	17,472 btuh
Latent Gain	3,570 btuh	4,928 btuh
Net Gain	23,800 btuh	22,400 btuh
KW	1.55	1.55

Controlling Indoor Moisture

Pro’s and Con’s

+ Relatively inexpensive and simple to install.

- Only provides enhanced dehumidification when there is a call for cooling.

Controlling Indoor Moisture

Strategy 2 – Bring on the cooling system for dehumidification

Sequence of operation – When indoor humidity climbs above set-point, thermostat energizes cooling to dehumidify the air. Cooling will continue to operate until indoor temperature drops 1ºF to 3ºF below cooling set-point.

Controlling Indoor Moisture

Pro's and Con's

+ Relatively inexpensive and simple to install. Just requires configuration in setup.
+ Removes humidity upon a call. Doesn't rely on cooling demand.

- Lowering temperature, raises RH.
- Potential to over-cool the home.
- Not very effective at low indoor db temperatures.

Controlling Indoor Moisture

Strategy 2b – Carrier, Bryant Ideal Humidity Control (Infinity – Evolution)

Sequence of operation – When indoor humidity climbs above set-point, thermostat energizes cooling to dehumidify the air and slows the indoor blower to enhance moisture removal. Cooling will continue to operate until indoor temperature drops 1ºF to 3ºF below cooling set-point until indoor temp reaches 70ºF

Controlling Indoor Moisture

Pro’s and Con’s

+ Removes humidity upon a call. Doesn’t rely on cooling demand.
+ Provides more humidity removal through slowing indoor blower.

- Expense
- Sophistication for both installer and operator
- Lowering temperature, raises RH.
- Potential to over-cool the home.
- Not very effective at low indoor db temperatures.

Controlling Indoor Moisture

Strategy 3 – Bring on the cooling system for dehumidification – Add reheat to prevent overcooling.

Sequence of operation – When indoor humidity climbs above set-point, thermostat energizes cooling to dehumidify the air. Indoor blower reduces speed to enhance moisture removal. Cooling will continue to operate until indoor humidity set-point is achieved. Heat is provided up-stream of the evaporator coil to prevent over-cooling the home.

Challenge is using a source of reheat that is affordable.

Controlling Indoor Moisture

Strategy 3a - Geothermal Option

Triple function geothermal unit heats and cools the home as well as heating domestic water. Average COP = 4.0. Use hydronic coil upstream of the evaporator coil to provide reheat.

Controlling Indoor Moisture

Controlling Indoor Moisture

Controlling Indoor Moisture

Strategy 3b - Solar Reheat Option

Using a conventional heat pump to heat and cool the home, a hydronic coil upstream of the evaporator coil to provide reheat. Reheat is provided through solar thermal.

Controlling Indoor Moisture

Controlling Indoor Moisture

Controlling Indoor Moisture

Pro’s and Con’s

+ Removes humidity upon a call. Doesn’t rely on cooling demand.
+ Provides more humidity removal through slowing indoor blower.
+ Very efficient in all modes. (heating, cooling and dehumidification. Solar is plentiful in shoulder seasons.

- Expensive to install
- Sophistication for installer.

Controlling Indoor Moisture

Strategy 4 – Four (4) pipe hydronic air handler with chilled water coil for cooling and dehumidification.

Sequence of operation – When indoor humidity climbs above set-point, thermostat energizes chilled water circulator pump (less than 100 watts). 38ºF to 42ºF water circulates through chilled water coil. Blower speed is reduced to enhance humidity removal. Chilled water will continue to operate until indoor humidity set-point is achieved. Heat is provided up-stream of the evaporator coil to prevent over-cooling the home.

Controlling Indoor Moisture

Four pipe air handler
with ECM motor

Reverse Cycle
Geothermal Unit

Controlling Indoor Moisture

Controlling Indoor Moisture

Pro’s and Con’s

+ Extremely flexible. Can be used for radiant, warm air heating, domestic water heating, ice melting, pool heating and reheat.
+ Removes humidity upon a call. Doesn’t rely on cooling demand.
+ Provides exceptional humidity control
+ Very efficient in all modes. (heating, cooling and dehumidification. (COP = 5.5)
+ Simple and reliable

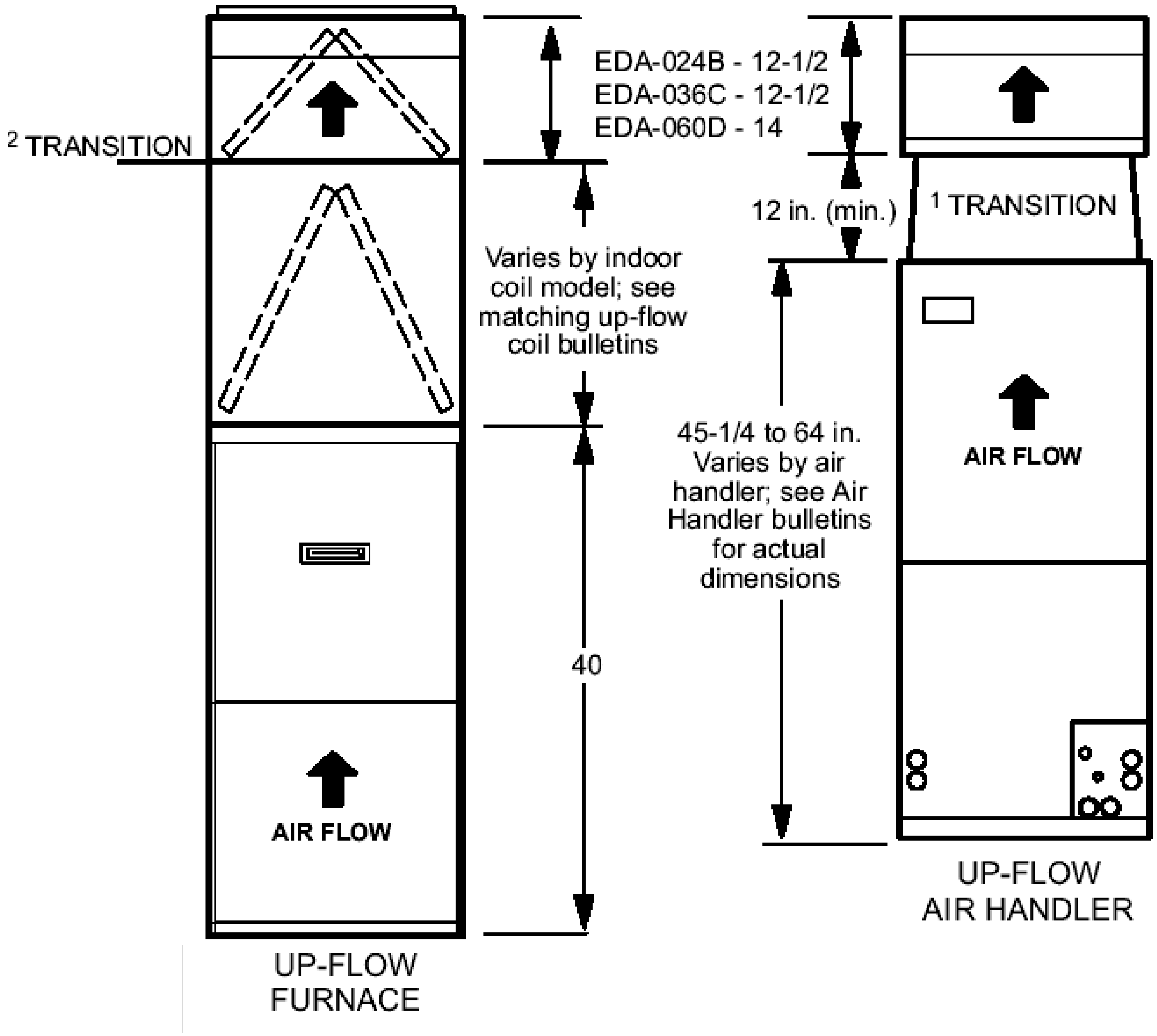
- Expensive to install
- Sophistication for installer.

Controlling Indoor Moisture

Strategy 5 – Lennox Humiditrol

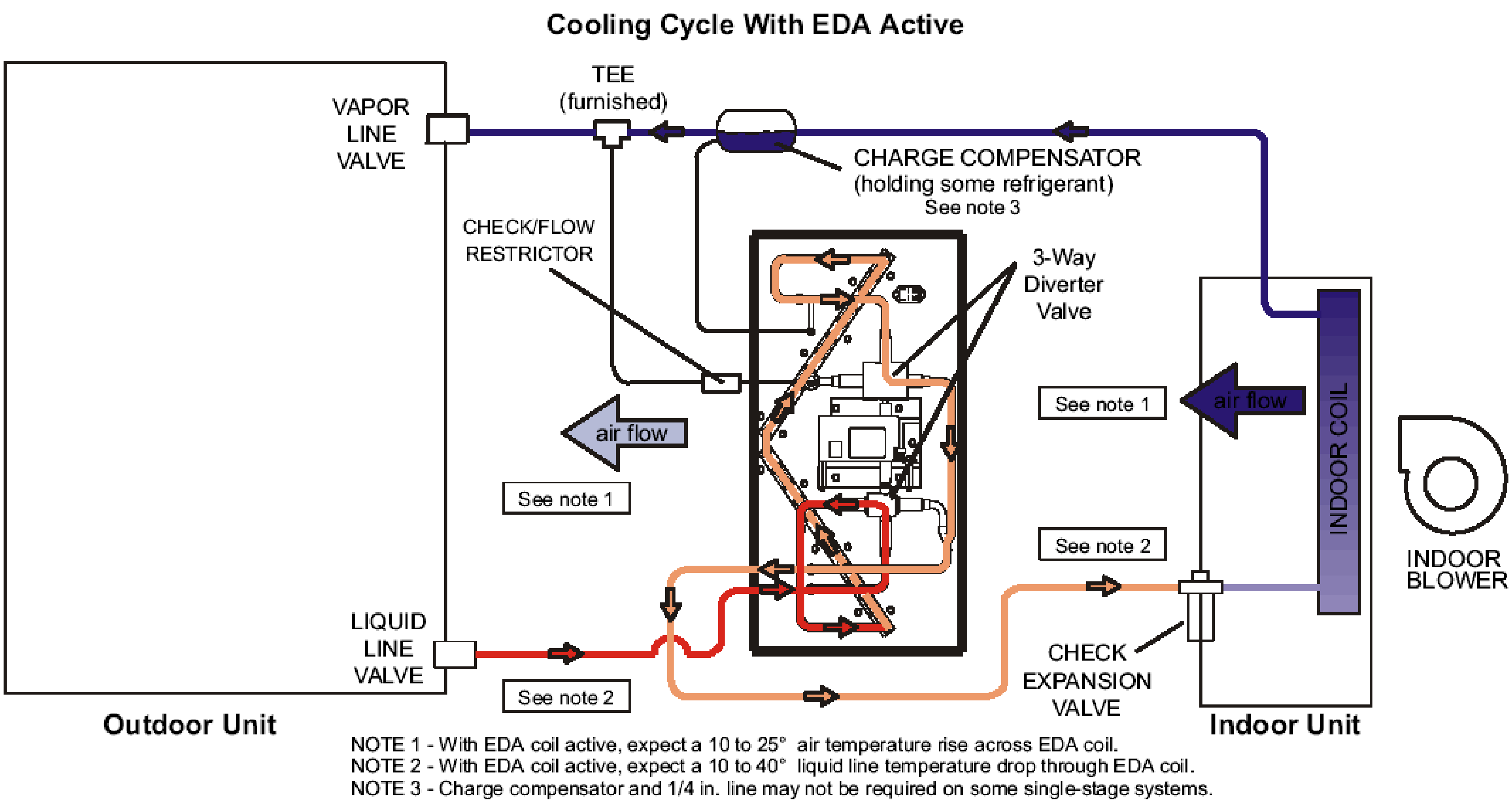
Controlling Indoor Moisture

Lennox Humiditrol



Controlling Indoor Moisture

Strategy 5 – Lennox Humiditrol



Controlling Indoor Moisture

Pro's and Con's

+ Removes humidity upon a call. Doesn't rely on cooling demand.
+ Provides exceptional humidity control
+ Moderately efficient

- Expensive to install
- Sophistication for installer
- Cannot be used with zoning

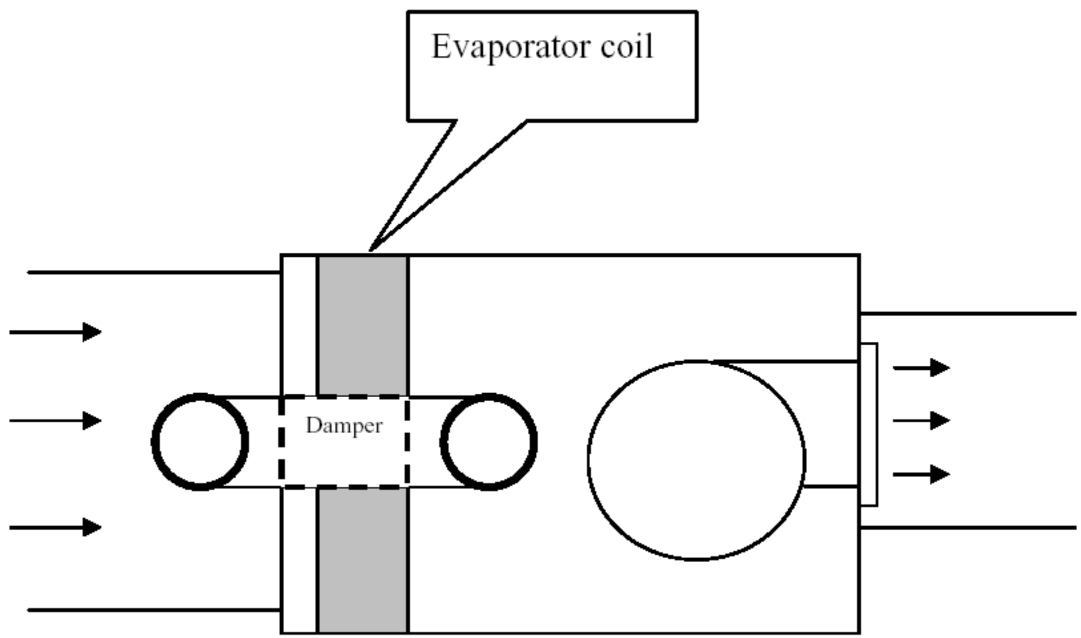
Controlling Indoor Moisture

Strategy 6 – Face & Bypass

Sequence of operation – When indoor humidity climbs above set-point, thermostat energizes cooling system. Modulating damper opens to bypass return air necessary to maintain 32ºF- 34ºF evaporator coil temperature. Colder coil enhances humidity removal. Unit will remove approximately 4 pints per hour per ton.

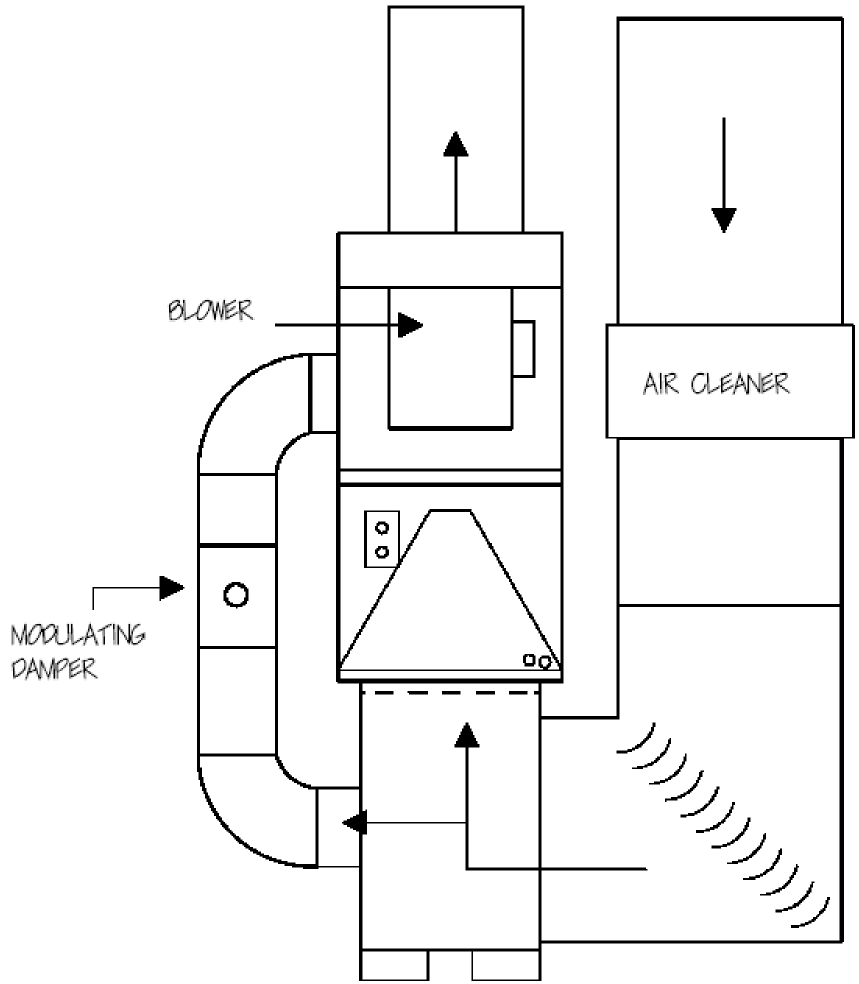
Controlling Indoor Moisture

Strategy 6 – Face & Bypass



Controlling Indoor Moisture

Strategy 6 – Face & Bypass



Controlling Indoor Moisture

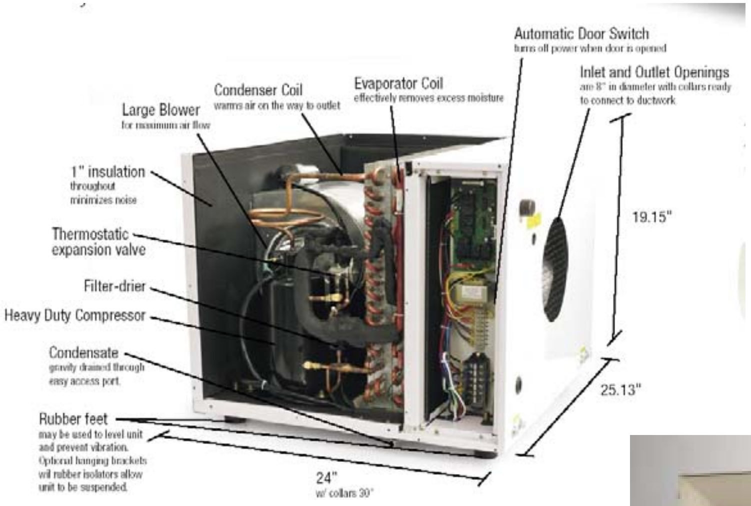
Pro’s and Con’s

+ Removes humidity upon a call. Doesn’t rely on cooling demand.
+ Provides exceptional humidity control
+ Moderately efficient

- Moderate cost
- Sophisticated controls
- Have to cut hole in the new air handler cabinet

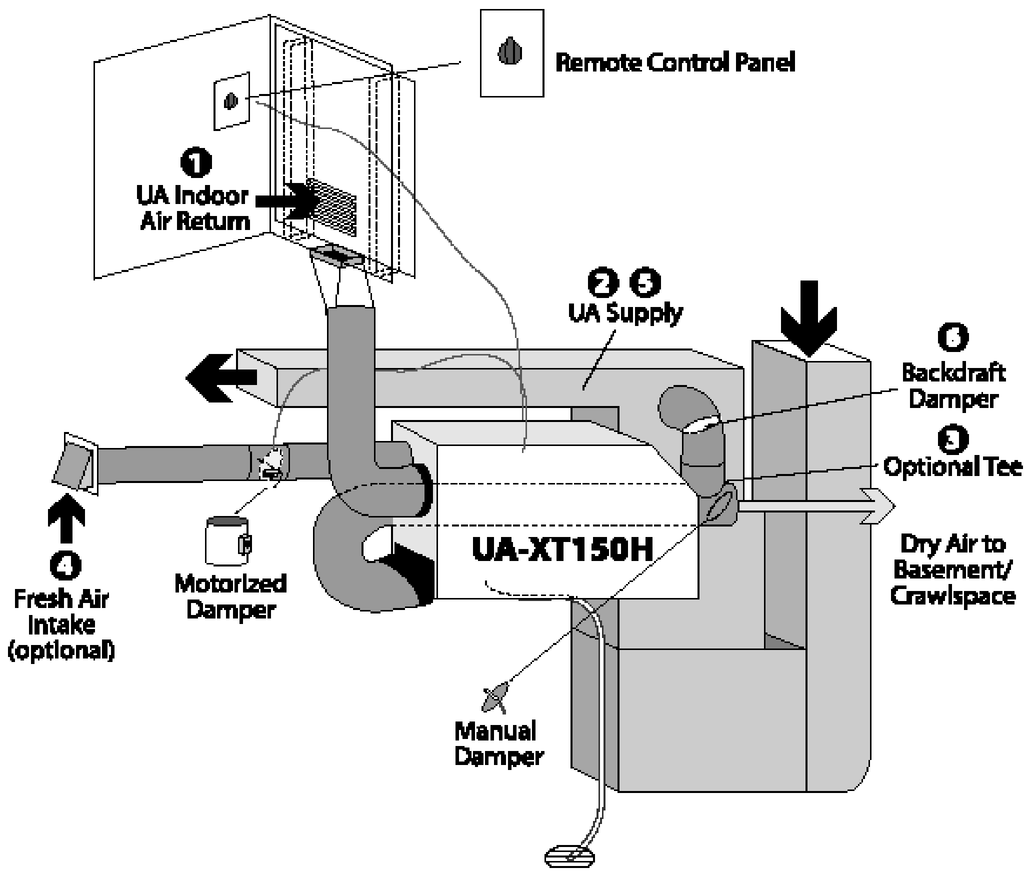
Controlling Indoor Moisture

Strategy 7 – Whole House Dehumidifier



Controlling Indoor Moisture

Strategy 7 – Whole House Dehumidifier



Controlling Indoor Moisture

Strategy 7 – Whole House Dehumidifier

Controlling Indoor Moisture

Strategy 7 – Whole House Dehumidifier

Pro’s and Con’s

+ Removes humidity upon a call. Independent of cooling system
+ Provides exceptional humidity control.
+ Can be used to pre-dry ventilation air.
+ Very efficient, (7.9 pints per kwh - Thermastor)

- Cost
- Logistics for duct work.
- Adds sensible heat to the structure.
- Noise

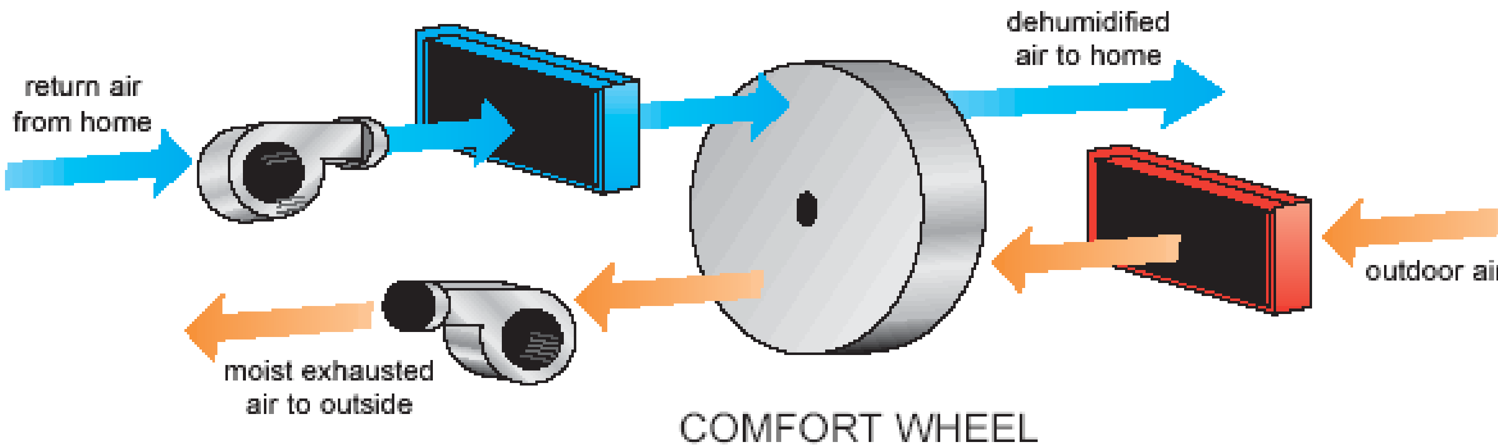
Controlling Indoor Moisture

Strategy 7b – Desiccant Dehumidifier

Sequence of operation – When indoor humidity climbs above set-point, thermostat energizes dehumidification system. Indoor air is passed of desiccant wheel, which absorbs water vapor. Desiccant must be regenerated to absorb more vapor.

Controlling Indoor Moisture

Strategy 7b – Desiccant Dehumidifier



Controlling Indoor Moisture

Strategy 7b – Desiccant Dehumidifier

Pro’s and Con’s

+ Removes humidity upon a call. Independent of cooling system.

- Cost
- Efficiency dependent on outdoor conditions and gas pricing. (200 pints/day rated at 5.6 pints/kwh)
- Logistics for duct work

Controlling Indoor Moisture

Strategy 7c – Heat Pipe Dehumidifier

Controlling Indoor Moisture

Strategy 7c – Heat Pipe Dehumidifier

Pro’s and Con’s

+ Removes humidity upon a call. Independent of cooling system.

- Cost
- Efficiency - 250 pints/day rated at 3.2 pints/kwh
- Adds 8500 btuh sensible to the structure
- Logistics for duct work

Controlling Indoor Moisture
Questions ?