

Achieving a moisture balance
within the home !?

for

2018

Energy Design Conference

By

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- Learn the basic principles of building science. How heat, air and moisture impact the occupants and the components of the home.

Why is Moisture Important?

- ▣ Moisture damage contributes to over 90% of all building and building material failures (ASHRAE)
- ▣ Except for structural errors, moisture is the leading cause of building problems costing more than 9 billion dollar annually in the US. (ASTM)
- ▣ Moisture-related problems lead the list of top callbacks for most builders.
- ▣ Several consumer surveys, list moisture problems as a primary concern

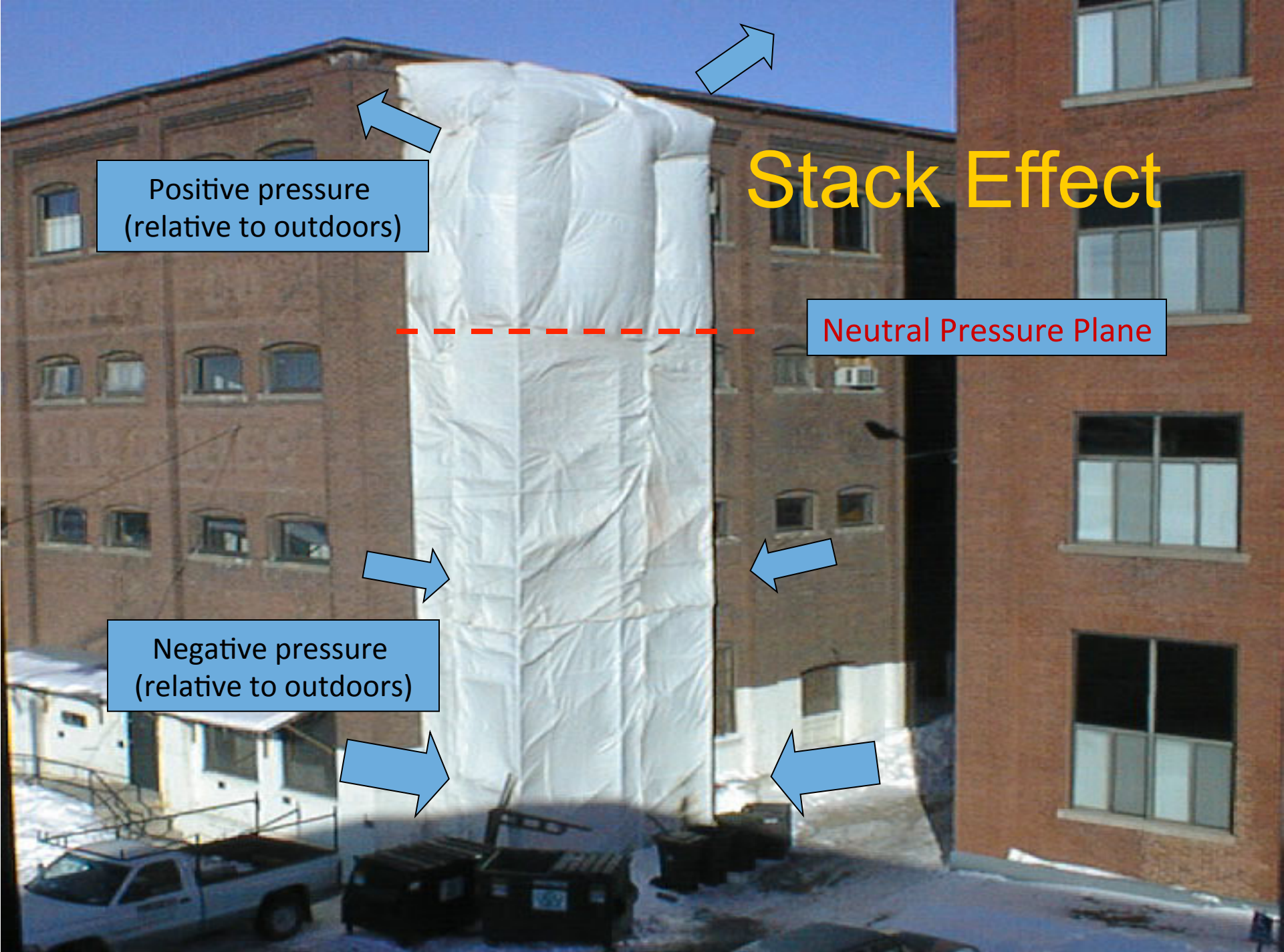
Moisture Flows

- Gravity
 - Rain & soil pressure
- Capillary
 - Material wicking
- Diffusion
 - Vapor pressure drive
- Air transport
 - Pressure induced flows of moisture laden air

The Rules of Building Performance

- Moisture moves from more to less
- Moisture move from warm to cold
- Heat flows from warm to cold





Stack Effect

Positive pressure
(relative to outdoors)

Neutral Pressure Plane

Negative pressure
(relative to outdoors)

Problem: Ice Dams, Frost in Attics

▣ Solution:

- Continuous air/vapor barrier in ceiling
- Sealed fixtures
- All penetrations sealed

▣ Benefits:

- Reduces heat loss & moisture flow through the ceiling which helps reduce ice dams and frost.



Siding failure, cavity pressurization



Humidity and Building Science

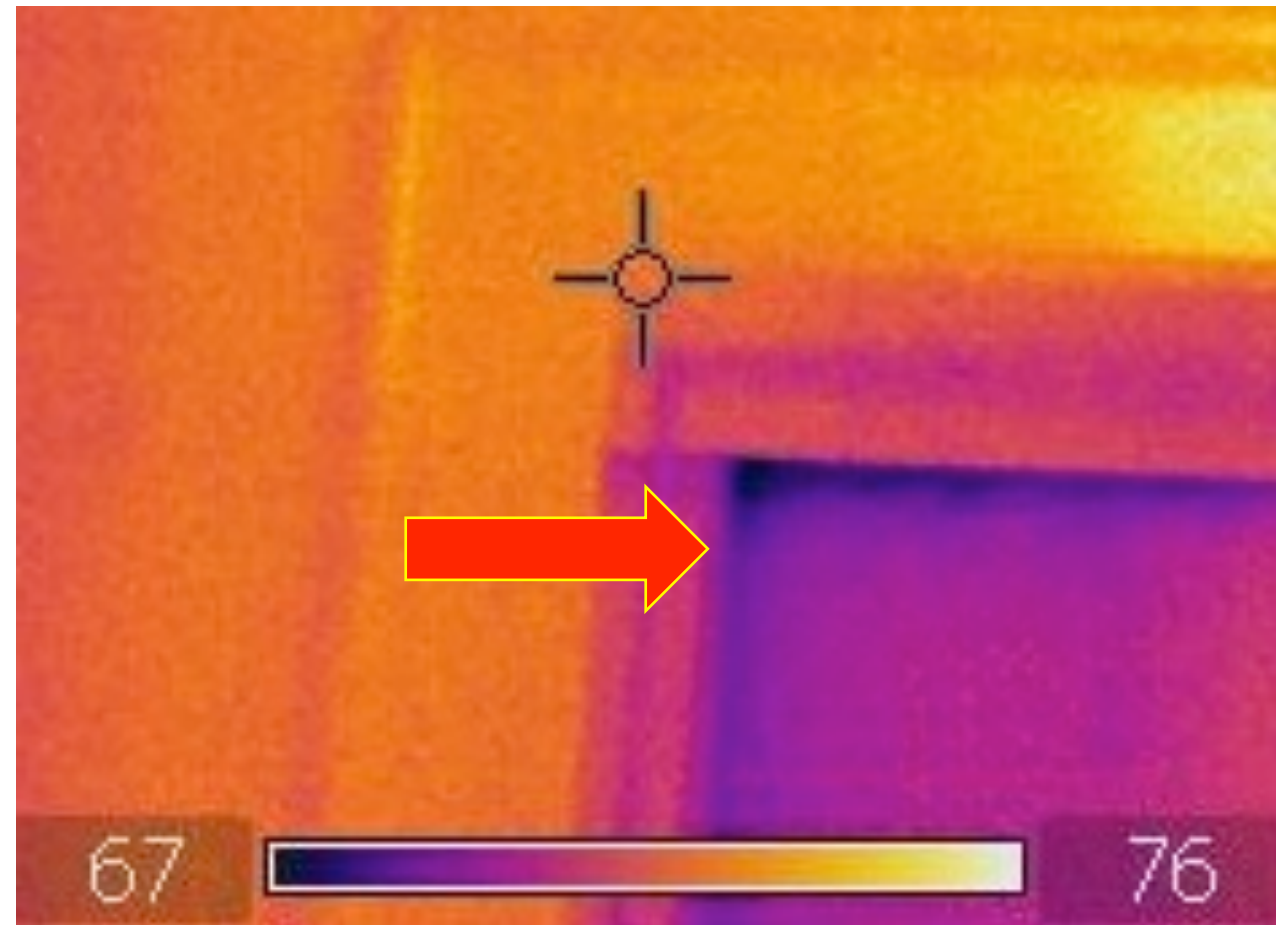
- Bulk moisture
- Source of humidity
- High humidity goes to low humidity
- Vapor pressure drive
- RH% range in winter 25% to 40%
- As temp goes down RH% goes up 1.7 rule... set back

Condensation

- LIFESTYLE ?
- VENTILATION ?
- HUMIDIFIER OPERATION ?
- TEMP. OUTSIDE AND INSIDE ?
- RH% RELATIVE HUMIDITY?



This is a Infar-red picture of a window the darker color shows colder surfaces, by the nature of how all windows are built the edges are going to be colder



Foundation

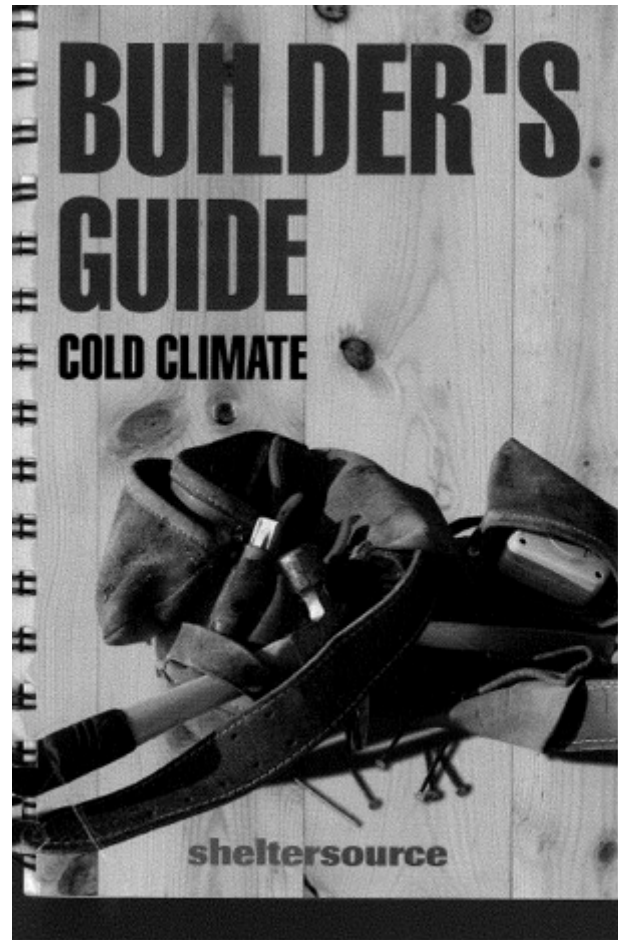
- Keep the groundwater out
- Keep the soil gas out
- Keep the water vapor out
- Keep the heat in during the winter



Condensation in the Building Assemblies

- Can lead to mold and rot
- Can cause building failures in, siding, rim joists, walls, frost and moisture in attic
- Can lead to litigation and some very \$ expenses repairs
- The higher the RH% is in the winter the more the structure has a potential for problems
- Proper RH% and air sealing/insulating can solve these problems
- **Follow Systems Approach**

Info on line





VAPOR BARRIER...SEALED LIKE A PLASTIC BAG



Tools you need

- Equipment that is calibrated to do duct leakage testing
- Formula or software to do the calculations
- Equipment that I use
- Duct Blaster, The Energy Conservatory
 - DG -700 digital manometer
 - Duct Blaster fan with rings
 - Instructions and software
- Duct mastic
- Duct mask or plugs
- Lights (trouble and flash)
- Smoke (fogger or hand held)



Duct mastic UL 181, new code



A little
busy



Job site coordination



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- Learn why the selection of building products and building shell design can have a significant impact on surface condensation, ice dams, comfort, and energy efficiency

Design and Durability

Wet and dry

Angles ,roof details

Box vs a lot of different planes



Window selection



Air flow damper selection



Open damper in fireplace ?



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- Go over Mechanical Equipment selection and look at what is new on the market, a broad discussion on how the equipment interacts with what the humidity will be in the house

New HVAC Technology

- Improve Comfort
- Maximize Energy Savings
- Enhance Safety
- Provide Additional Convenience
- Address Design/Access Issues

Mechanical Equipment selection

- Discussion with the mechanical contractor what the comfort package includes
- What's new and if it works
- Value vs. cost
- How do systems work together
- Long term issues, operation and maintenance



Heating systems

- Air source heat pumps
- 2-Stage furnaces
- Dual fuel
- Plenum heaters
- Wood furnaces
- Modulating systems
- Geo ground

Ductless Cooling & Heating

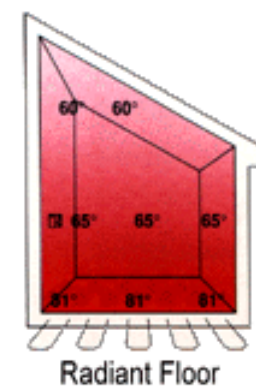


- Very cost-effective method of adding cooling to existing home without forced air or addition
- Up to three-zone capability
- With new Inverter Heat Pump technology, heating can be added to an addition with electric baseboard backup where other methods will not work

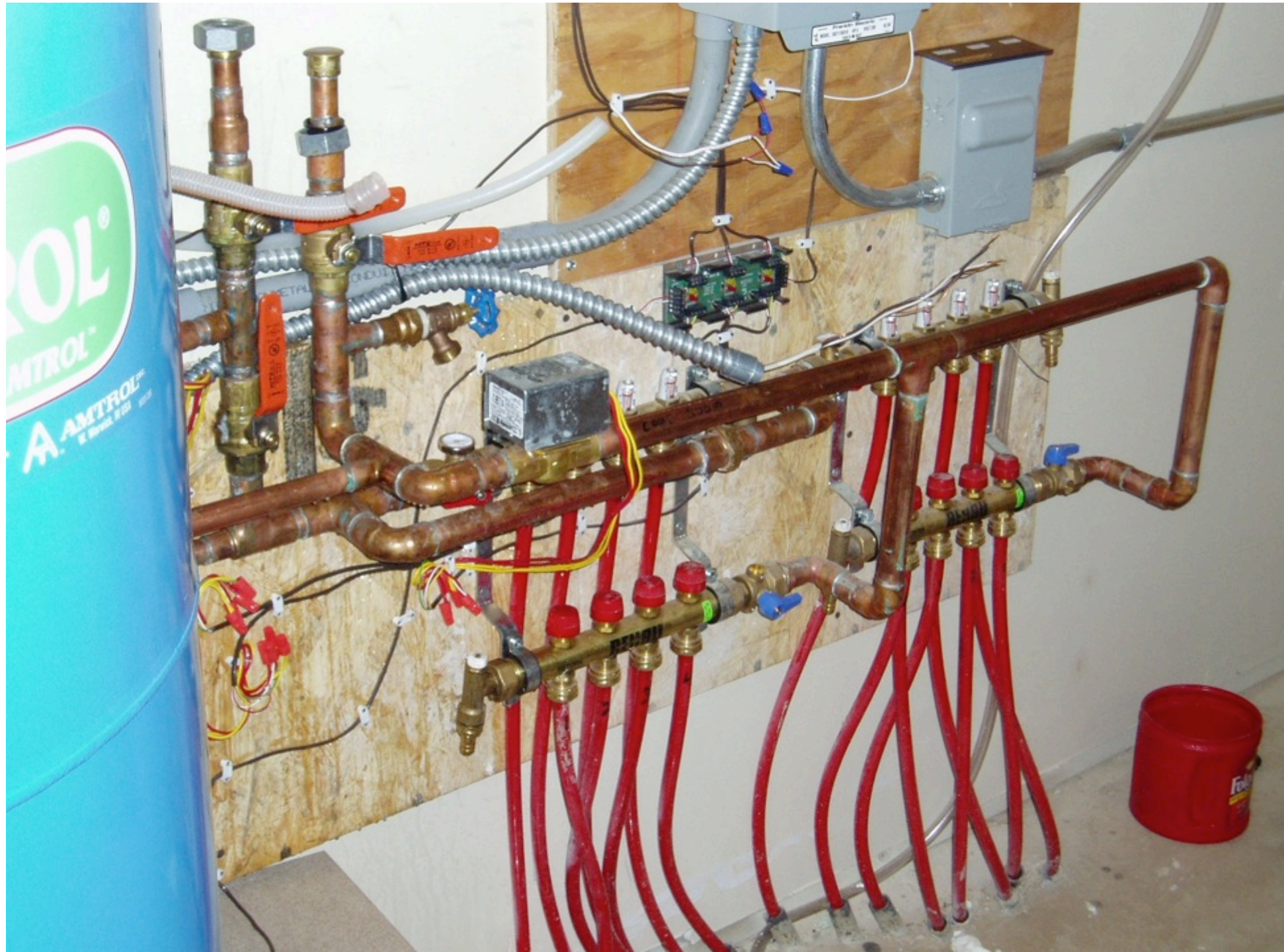
Small mechanical room, u turn was ok



Radiant Heating



- Radiant Heating is the most comfortable type of heat, especially for basements
- Other methods of keeping a basement or slab on-grade home include zoning, gas fireplaces, spot electric baseboard, but **NOT** underground duct systems!
- Underground duct systems have too many potential issues and if it gets wet, the consequences are just too serious to warrant its use!



Variable Speed DC Blowers

- Blower can speed up and slow down to deliver the required air flow – may be solution to challenging duct access/design issues
- Operating cost a fraction of conventional blowers
 - Saves \$150 per year in operation cost vs. conventional blower
 - Cost to operate continuously less than conventional blower operating intermittently
 - If blower is run continuously, payback is about 2 years – up to \$400 annual savings

Advantages of Continuous Blower Operation

- Minimizes temperature stratification
- Keeps Air Cleaning and Humidification System running for optimal performance
- Helps to deliver ventilation air to all rooms
- Fresh feeling

New Control Systems

- New easy to use programmable thermostats
 - Attractive
 - Easier to use
 - Programmable Fan
 - Circulate Fan Mode
 - Wi-Fi



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- Understand what is the relationship between the ventilation strategy and how to humidify the home in the cold weather months

DIFFERENCE BETWEEN HRV AND ERV

- HRV are by far most common type installed units
- HRV is best to reduce window condensation
- ERV will retain more humidity in home in the winter
- ERV will bring in less humidity in summer
- Climate, cost and application is the driving factor on what type is selected

Methods of Ventilation

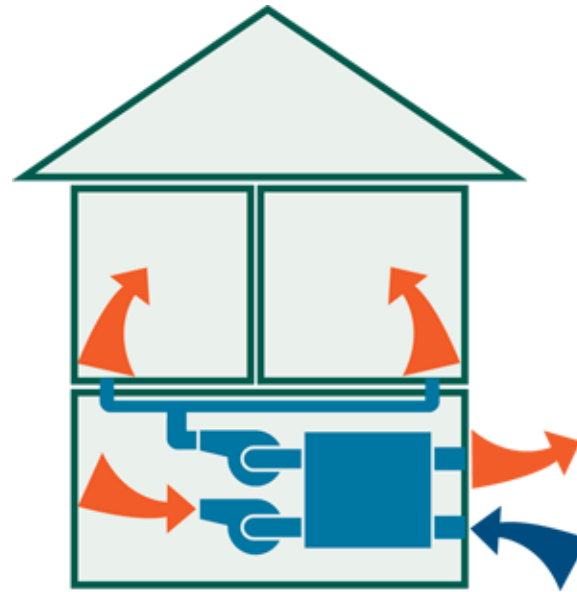
- **Continuous:** Sometimes referred to as general, central, or whole-house ventilation. Should be quiet, low volume, and continuous ventilation
- **Intermittent:** Sometimes referred to as spot, local, or source point ventilation. Commonly used in bathroom, kitchen, laundry, hobby, and home office. Should remove excessive moisture and pollutants quickly

Ideally, an airtight home designed with both continuous and Intermittent ventilation will contribute to a healthy and comfortable living environment for the entire family

Balanced

Supply air flow is equal
(C.F.M.) to exhaust

Balancing is required to
all units

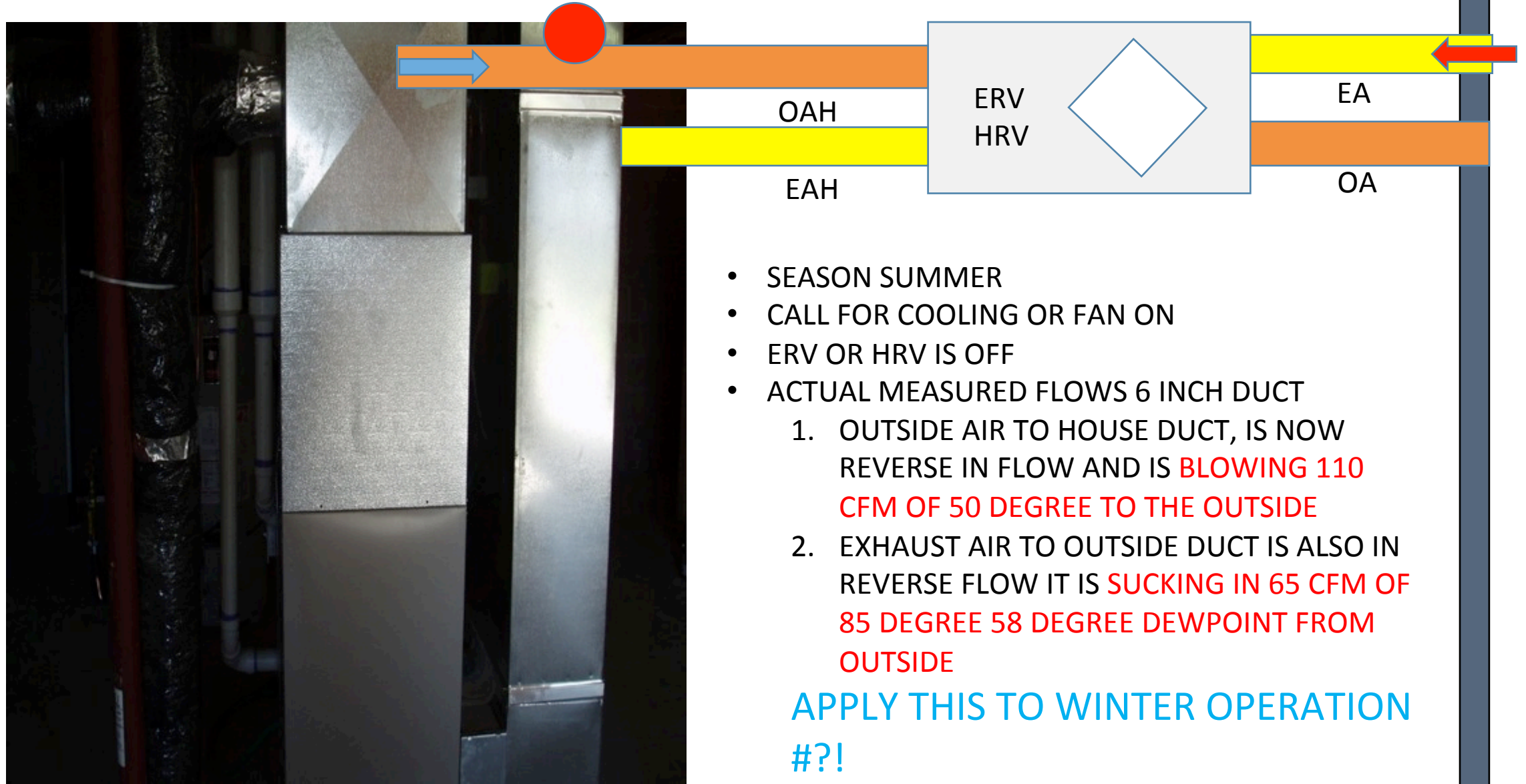




HRV/ERV installation without dampers that close to the outside



SUPPLY- RETURN DUCT DESIGN, NO DAMPERS



- SEASON SUMMER
- CALL FOR COOLING OR FAN ON
- ERV OR HRV IS OFF
- ACTUAL MEASURED FLOWS 6 INCH DUCT
 1. OUTSIDE AIR TO HOUSE DUCT, IS NOW REVERSE IN FLOW AND IS **BLOWING 110 CFM OF 50 DEGREE TO THE OUTSIDE**
 2. EXHAUST AIR TO OUTSIDE DUCT IS ALSO IN REVERSE FLOW IT IS **SUCKING IN 65 CFM OF 85 DEGREE 58 DEGREE DEWPOINT FROM OUTSIDE**

APPLY THIS TO WINTER OPERATION

#?!

Back flow demonstration

VENTILATION CONTROLS



WHAT IF SYSTEM IS NOT BALANCED ?

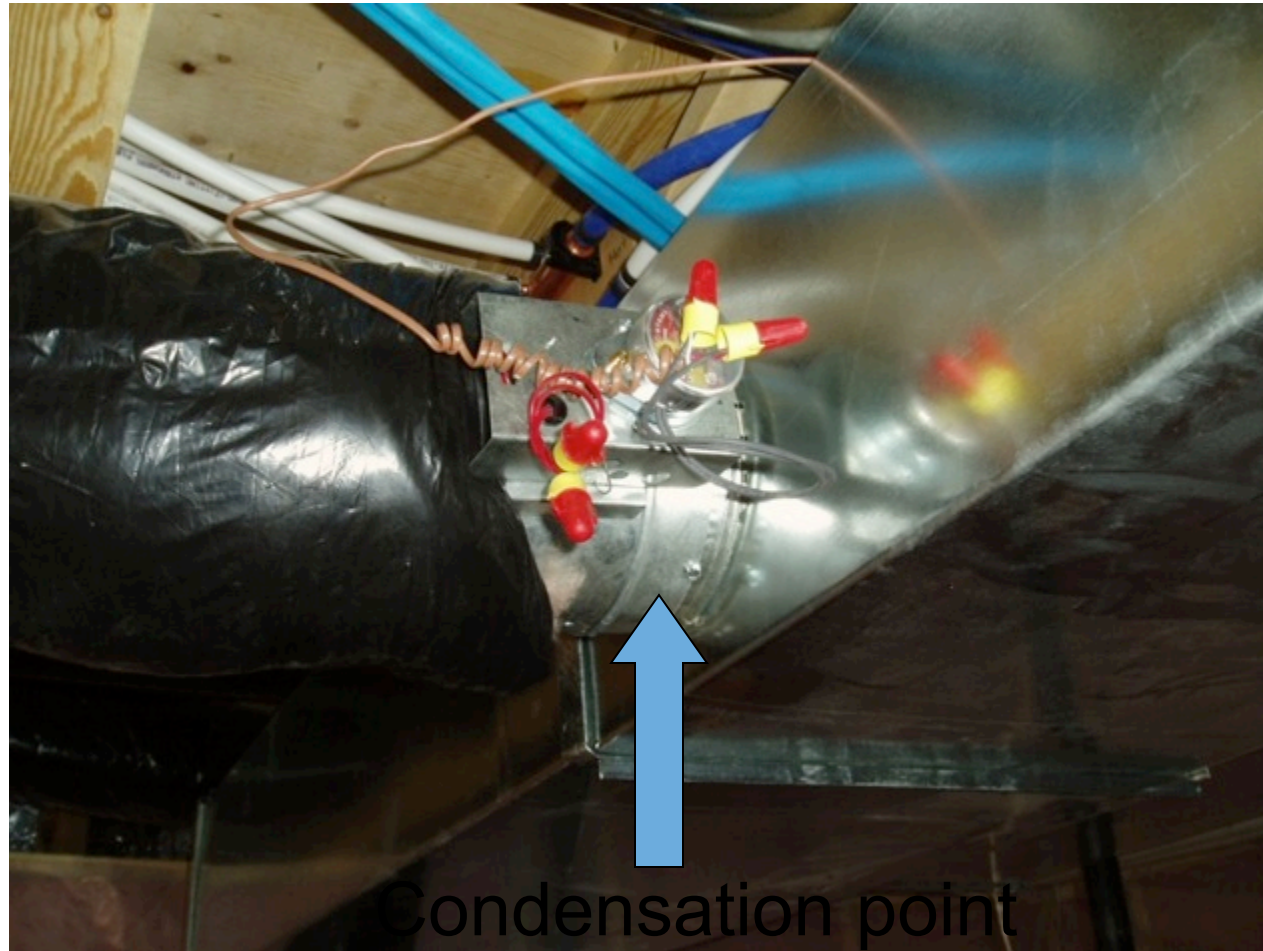
- Comfort complaints, call backs
- Core freeze up and blockage
- Waste of energy
- House can get to dry in winter, to humid in summer
- Building pressure issues

EXHAUST-ONLY



Supply only ventilation

Outside air ducted into the return



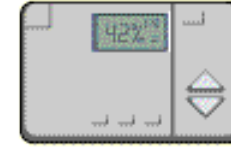
THREE TYPES OF HUMIDIFIER

- FLOW THRU BYPASS STYLE: MOST COMMON USES A LOT OF WATER
- ROTARY DISC HUMIDIFIER: LESS ENERGY AND WATER USE
- STEAM HUMIDIFIER: EFFECTIVE, MORE COSTLY

Bypass style with auto control



New Control Systems



- Temperature Compensating Humidity Controls - Automatically adjust humidity set point based on changing outdoor conditions
 - Ideal humidity level in the winter is as high as you can keep it without causing moisture on the windows
 - With manual humidistats, the humidity is always too high, causing moisture damage, or too low, causing discomfort

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- Learn about new solutions on how to improve comfort and control excessive humidity during the summer months.

Minnesota Cooling Challenges

- To be comfortable, need to lower temperature and humidity
- Thermostat only senses temperature
- Typical Summer day is low 80's but high humidity
- Need to have the capacity for temperatures in the 90's



Inverter Technology

- Low temp operation

On cooling around 14 degrees F

On heating around minus 5 degrees F some model minus 15

- Longer line sets
- 26 to 14 SEER on different models
- Several modes of operation

High velocity AC



Ducted unit, dropped ceiling, bath room



Closet install, clean no vibration



Dehumidification

High Capacity Humidity Control and Filtration



Santa Fe and Ultra-Aire

- Removes 100 pints of water per day
- Automatic defrost-effective operation down to 55F
- Uses less electricity per pint of water removed
- Drain hose directs water to floor drain

RH%, TEMP, DEWPOINT DATA FORM

| | | | | | | |
|----------------------|---------------------|--------|-----------|----------------|-----------|--|
| DATE | 7/20/2008 | | EQUIPMENT | ultra air 65 H | | |
| CUSTOMER | wilson | | | | | |
| ADDRESS | hackensack mn | | | | | |
| OUTSIDE CONDITION | 80 f 70 RH | | | | | |
| | | | 1 TEST TD | 2 TEST TD | 3 TEST TD | |
| SENSOR LOCATION | basement on counter | | | 900 SQ FT | | |
| RH% | | 65 | | 45 | | |
| TEMP | | 71 | | 75 | | |
| DEWPOINT | | 60 | | 51 | | |
| PINTS, REMOVAL | | 8 HRS- | | 14 | | |
| | | | | | | |
| SENSOR LOCATION | WOOD SHOP | | | 400 SQ FT | | |
| RH% | | 76 | | 51 | | |
| TEMP | | 68 | | 68 | | |
| DEWPOINT | | 61 | | 49 | | |
| PINTS, REMOVAL | | 9 HRS | | 20 | | |
| TESTO HUMIDITY STICK | | | | | | |
| SENSOR LOCATION | | | | | | |
| RH% | | | | | | |
| TEMP | | | | | | |
| DEWPOINT | | | | | | |
| PINTS, REMOVAL | | | | | | |
| | | | | | | |
| SENSOR LOCATION | | | | | | |
| RH% | | | | | | |
| TEMP | | | | | | |
| DEWPOINT | | | | | | |
| PINTS, REMOVAL | | | | | | |
| | | | | | | |
| SENSOR LOCATION | | | | | | |
| RH% | | | | | | |
| TEMP | | | | | | |
| DEWPOINT | | | | | | |
| PINTS, REMOVAL | | | | | | |
| | | | | | | |
| TD= TIME DURATION | | | | | | |

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- Before a remodeling project starts what to look for that may impact energy, IAQ, and moisture related issues. Discussion will be regarding energy saving/green solution, improving indoor air quality, and building shell details. Focus will be on features and equipment within the home that may contribute to moisture problems

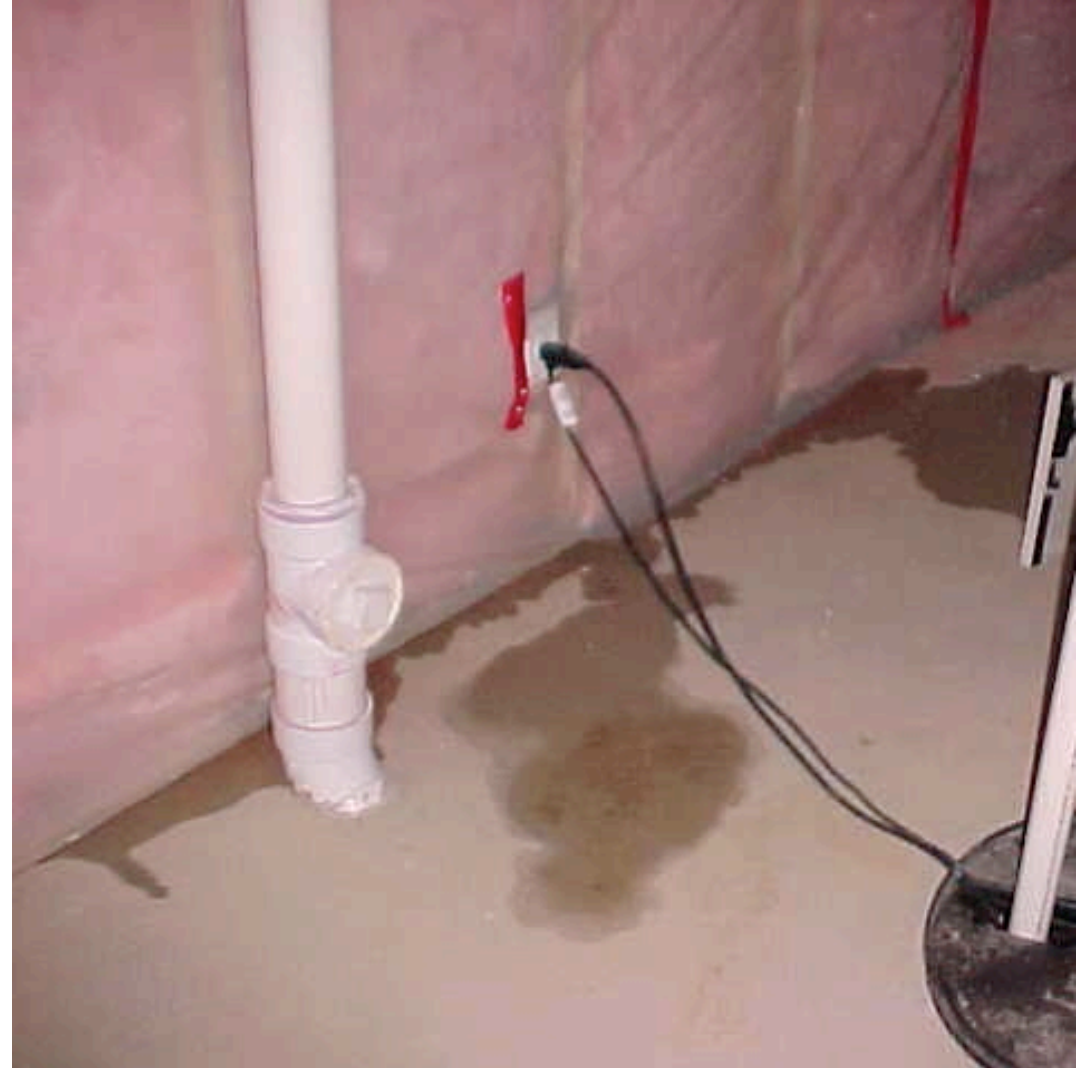
SEASONAL HOMES AND ADDITIONS



Water in the ductwork below slab



Foundation detail



Seal crawl space floors



Negative opening to Mechanical room (filter slot)



Air inlet system ? Fresh air



Combustion Safety Test Procedures:

- 1. Measure Ambient CO Levels in the House.**
- 2. Survey the Combustion Appliances.**
- 3. Survey the Exhaust Fans.**
- 4. Measure Worst Case Fan Depressurization.**
- 5. Conduct Spillage Test.**
- 6. Test Carbon Monoxide Production in Appliances
(including under back drafting conditions - be careful)**
- 7. Conduct Draft Test.**
- 8. Test Heat Exchanger Integrity (Forced Air Only)**

MAKE-UP AIR



*WHERE DO I
GET MY AIR
FROM ?*

Combustion air



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- Learn the basics of how to diagnosis a moisture problem, what to look for, tools to use. What to do if you find mold or wood floor failure, steps to take, question to ask. How to prevent the problem from reoccurring

Humidity gauge a must !



Ideal Levels of Relative Humidity

What is the ideal amount of relative humidity in the air?

Based upon Outside Air Temp. & Inside Relative Humidity

| | |
|-------|-------------------|
| -20°F | 15% Maximum |
| -10°F | 20% Maximum |
| 0°F | 25% Maximum |
| 10°F | 30% Maximum |
| 20°F | 35 to 40% Maximum |

National Wood, Window, and Door Association

Wood Floor Failure Summary

- 1. Uncontrolled jobsite moisture**
- 2. Wrong Parameters by HVAC**
- 3. Uncontrolled Rh by homeowner**
- 4. Radiant Heat Controls**
- 5. Wrong Product Choice**

High RH%, Bypass, lack of Ventilation



WATER STAINS





MOLD Growth

How can you help the homeowner

- If there is not enough ventilation in the bath room this can lead to mildew and **MOLD**
- Also there can be damage in the attic and ceiling will need to be repaired
- This can be costly to the home owner but more importantly mold can be a trigger to allergic reaction when you breath!
- Test flow with smoke bottle or bath tissue
- Recommend new fan or fix duct work

If you have mold

- Health department
- EPA
- Builder association

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- Review during final walk thru how the equipment works and how that interacts with the house/their lifestyle. Explanation of what should be maintained and why a planned maintenance program from the HVAC contractor should be recommended.
-

Homeowner education at walk thru and beyond

- What type of maintenance program do you have?
- Is the mechanical contractor going thru the equipment with the homeowner?
- Manuals and warranty info
- A generic DVD of how to take care of your home
- Online and third party info
- Exterior details

Explain to the homeowner... how it works and maintenance



SIMPLE DIAL TO WIFI WOW



MAINTENANCE

- General guide lines

Every 2-3 months

- Check and clean filters

Once per year

- Clean HRV/ERV cores
- Clean intake vents, grilles, hoods
- Check operation of dampers / controls

Air intake needs to be cleaned



Furnace filter?#\$!.... Basic stuff



Bath fans need cleaning



Thank you for your time

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