

# Installing Contractor Insulation Boot Camp

## Lesson 11: Moisture, Foundations, & Combustion Safety

# Lesson Topics



## What we will cover:

- Building science: common forms and sources of moisture in homes
- How to reduce moisture problems
- Combustion safety

# Building Science: Moisture in Homes



Moisture is associated with 90% of all building failures.

— American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)



# Question

A photograph of a modern, two-story house with a gabled roof and a large front porch. The house is light-colored with dark trim. A large, semi-transparent yellow rectangle is overlaid on the house, containing the text 'What are the three types of moisture?'. The background shows a clear sky and some landscaping.

What are the three types of moisture?

# Forms & Sources of Moisture

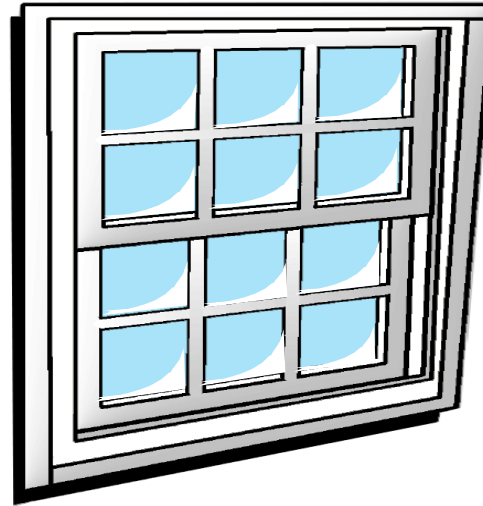
Bulk (liquid) moisture



Water vapor



Condensate



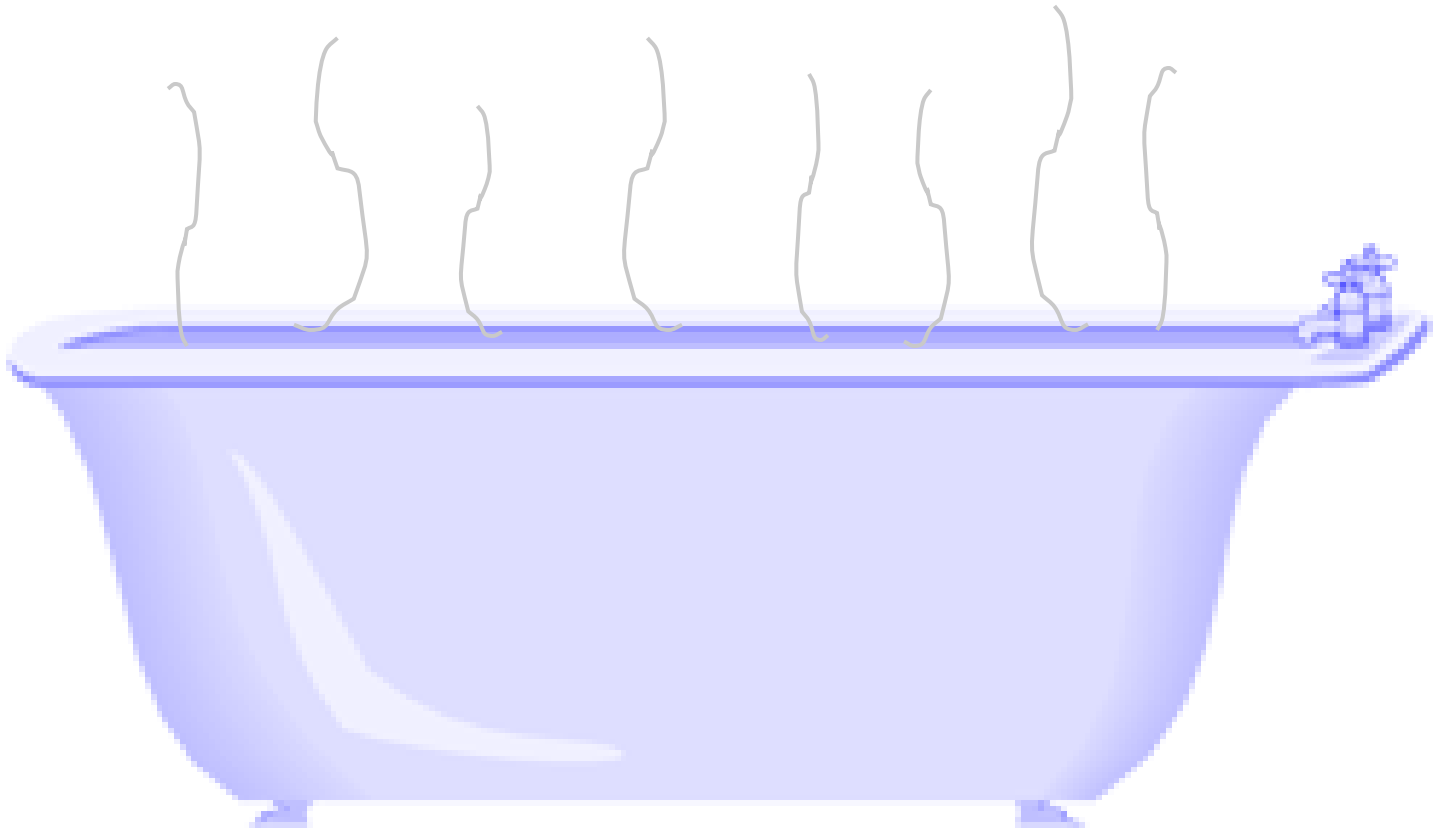
# Moisture Movement: Bulk

What are some examples of bulk moisture?



# Moisture Movement: Vapor

- What are some examples of water vapor?



# Moisture Movement: Condensate

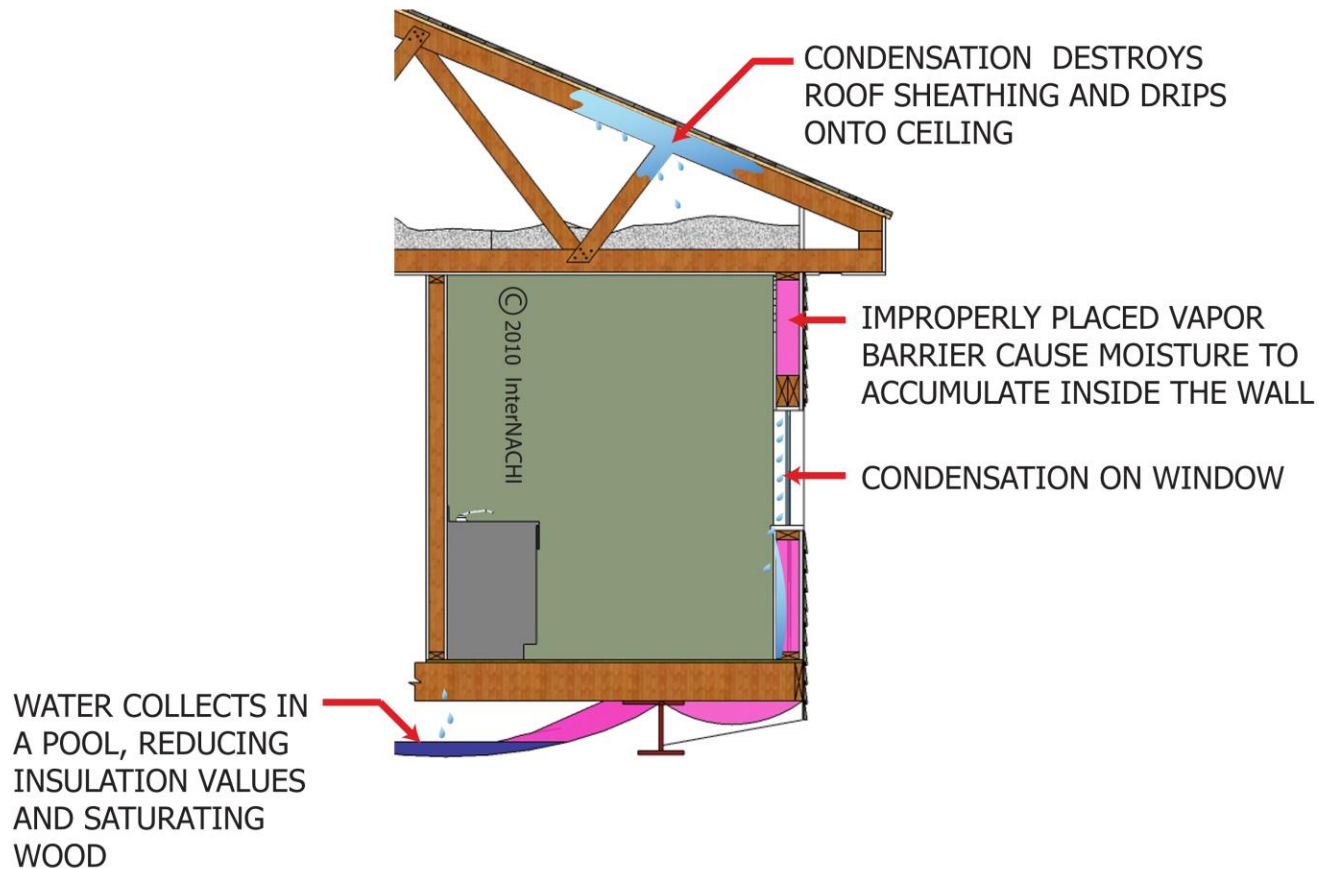
What are some examples of condensate?



Condensate is water vapor that condenses (changes back to water).

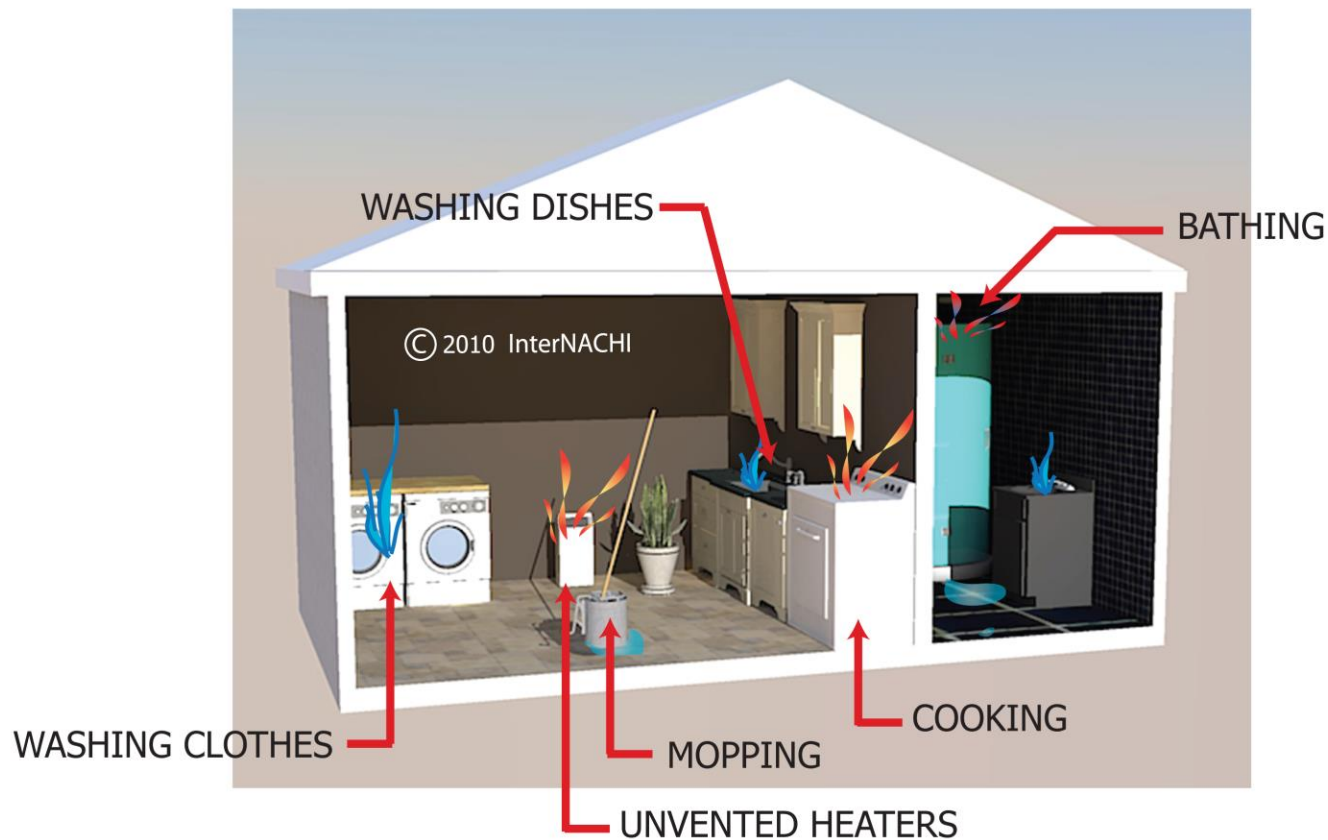
# Moisture Accumulation

## MOISTURE ACCUMULATION

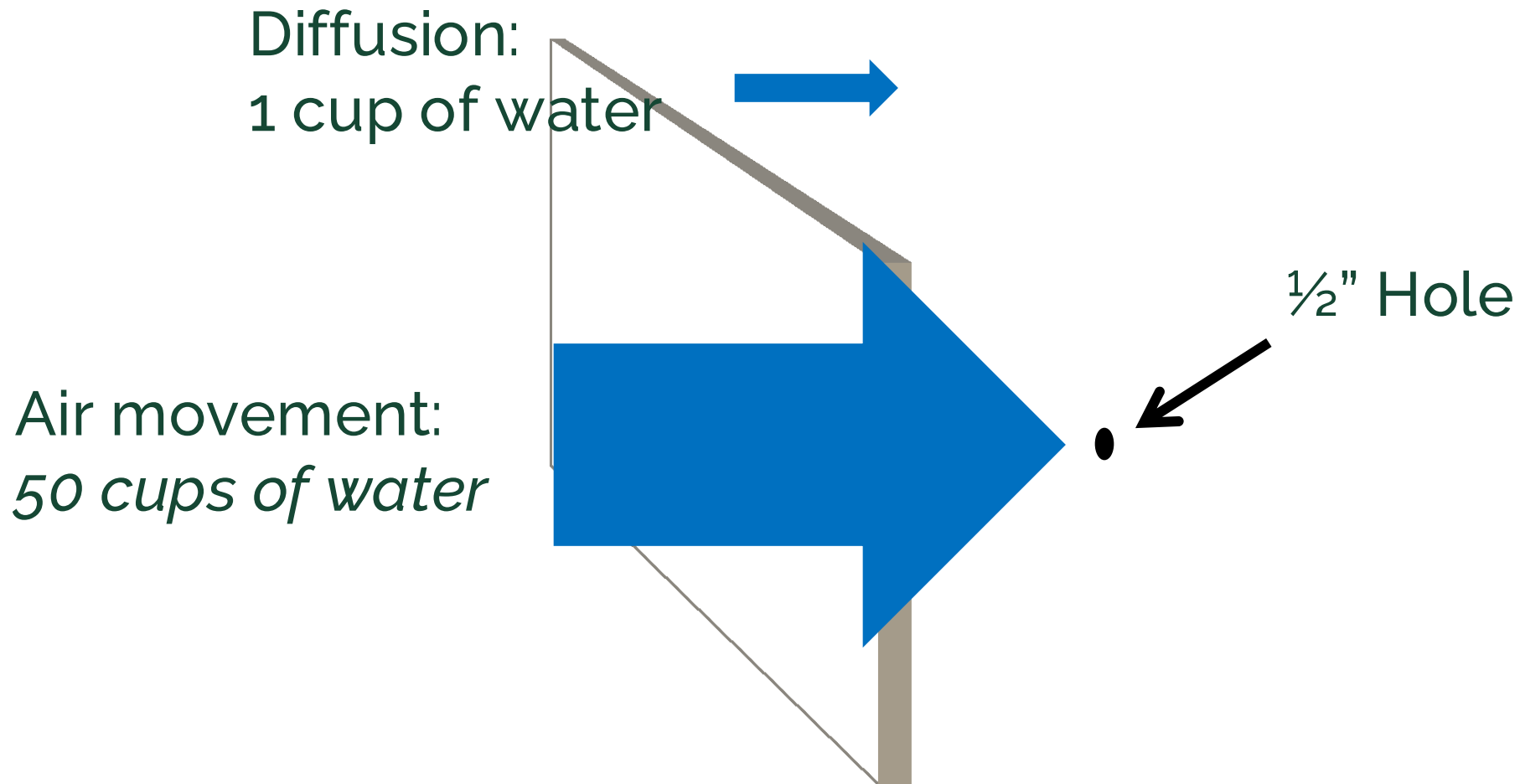


# Moisture from Domestic Activities

## MOISTURE PRODUCTION FROM DOMESTIC ACTIVITIES



# Water Vapor Movement



# Condensation

As the air temperature drops, so does its capacity to hold water vapor

Absolute  
Humidity

Air  
Temperature

Relative  
Humidity



95° F

55%

90° F

65%

85° F

76%

80° F

87%

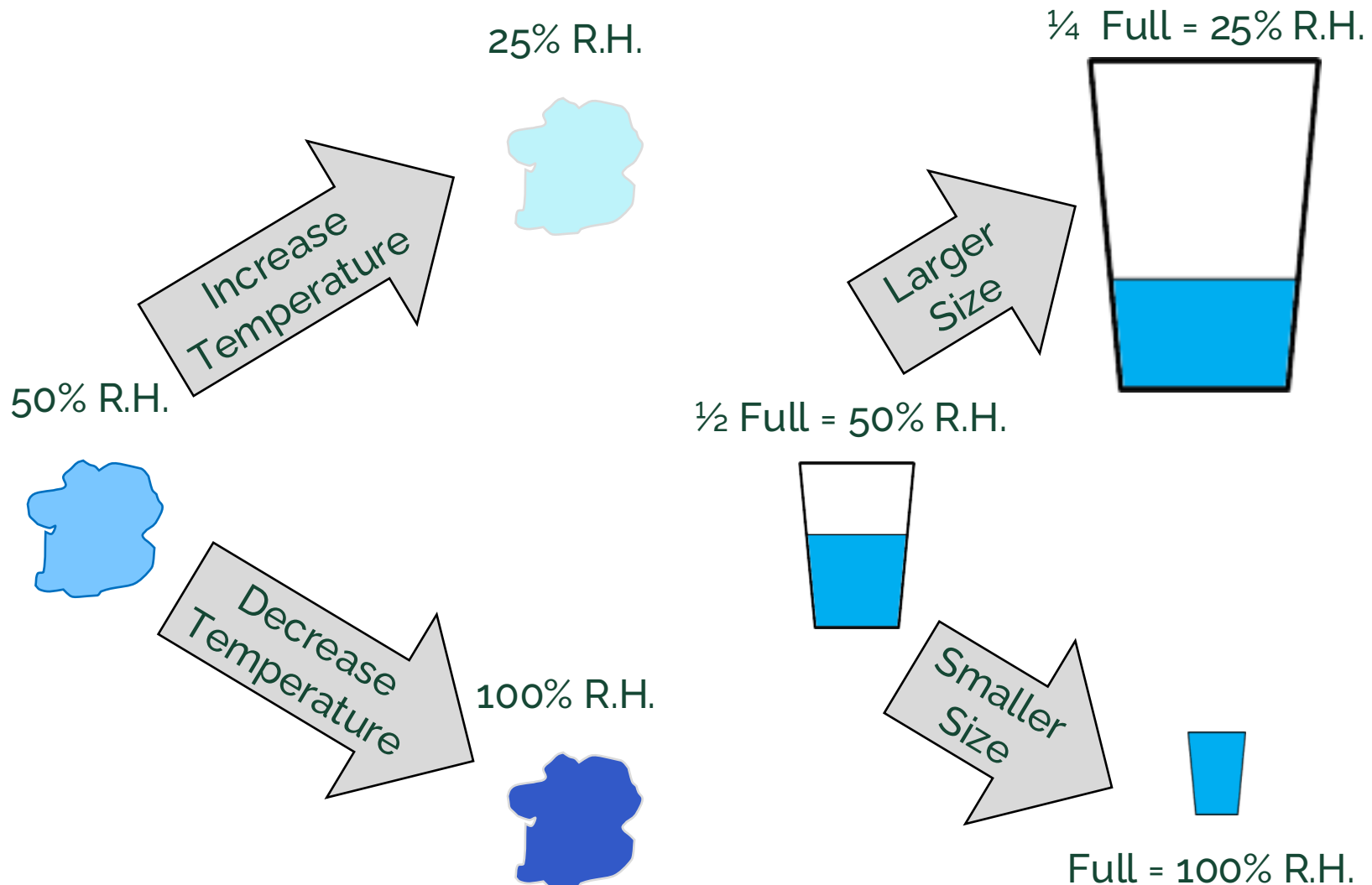
75° F

99%

70° F

Condensation

# Moisture in the Air: Humidity

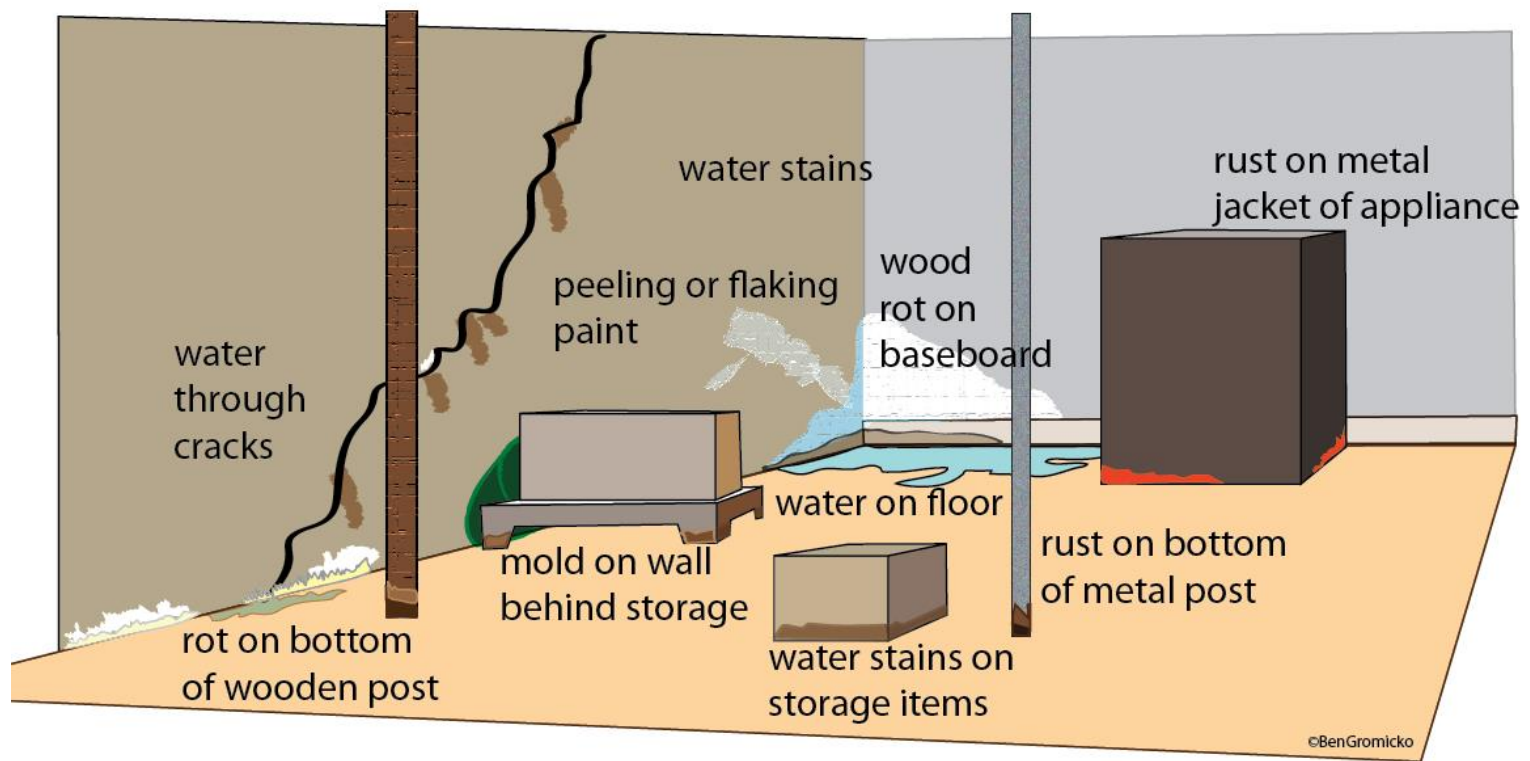


# Discussion: Moisture



1. What are some conditions caused by moisture that you may find in crawlspaces and basements?
2. What conditions might insulating the crawlspace and basement ceilings create?
3. What is one important way to reduce potential moisture problems from exposed earth floors?

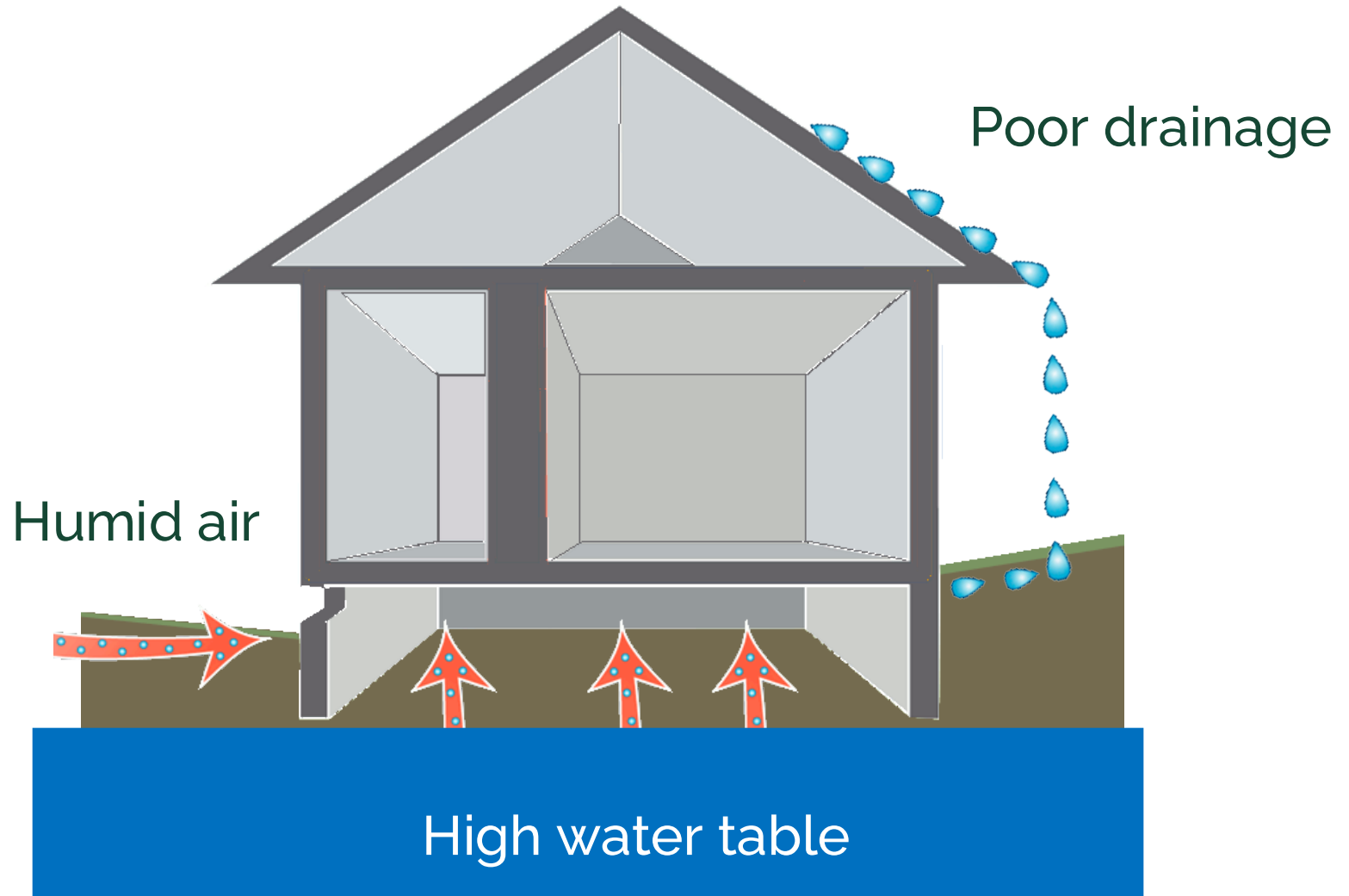
# Indications of Moisture Issues



# Causes

- Causes of moisture in the basement:
  - High water table
  - Poor drainage
  - Dirt floors
  - Open windows and vents
  - Unvented/poorly vented dryer
  - Unvented/poorly vented combustion equipment

# Source



# Vapor Barrier Installation



1. Assess the safety conditions of the area
2. Remove all storage and debris
3. Measure and cut the sheeting – allow for 1 foot lapping up the foundation walls
4. Lay the sheeting in place, minimum 6 mil, and secure it to the ground
5. Seal edges to the walls, obstructions, and sheeting seams with mastic or another permanent adhesive
6. All seams should overlap 6-12 inches

# Example 1: Before & After



## Example 2

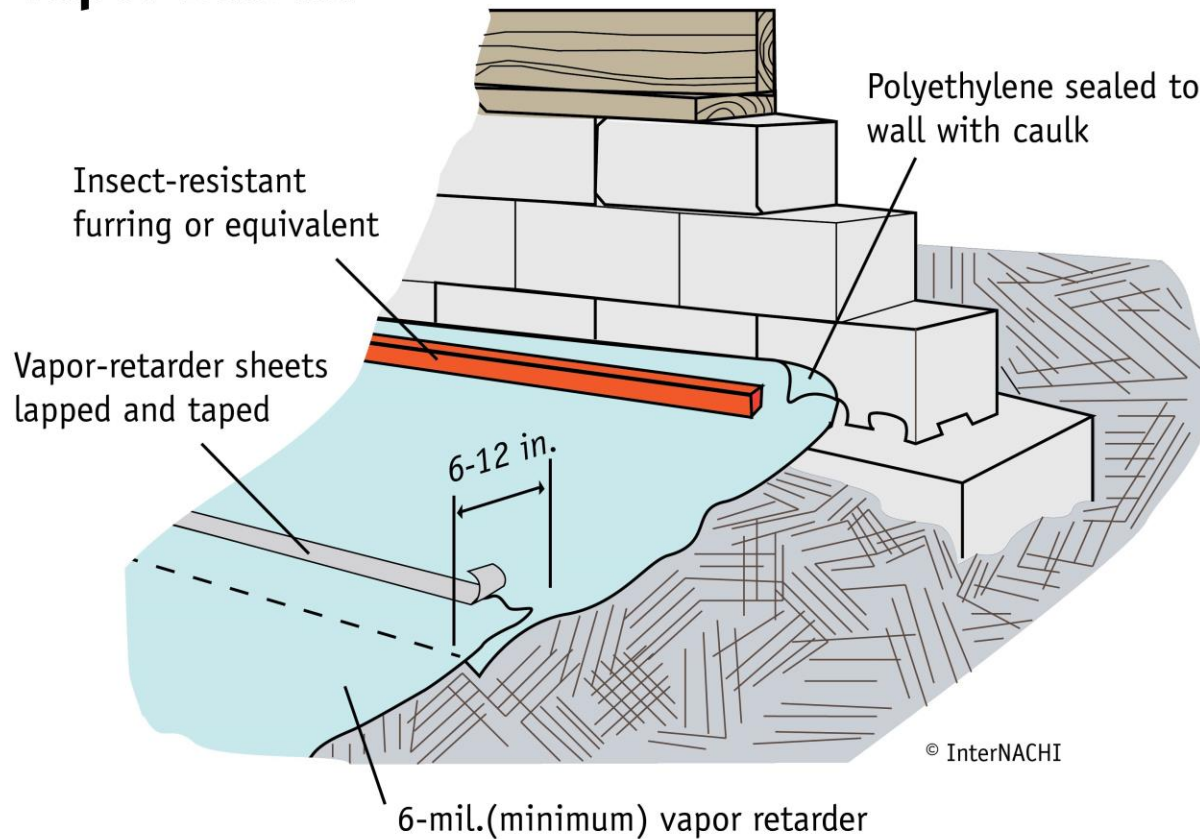


# Encapsulated Crawlspace



# Proper Crawlspace Vapor Barrier

## Proper Crawlspace Vapor Barrier



# Discussion

Why is water vapor condensing on the spray foam insulation in this crawlspace?



# Combustion Safety Overview



What we'll cover:

- Common combustion appliance types
- The relationship between weatherization and combustion safety
- Risks from exhaust gases, including carbon monoxide
- Warning signs

# Combustion Safety Awareness

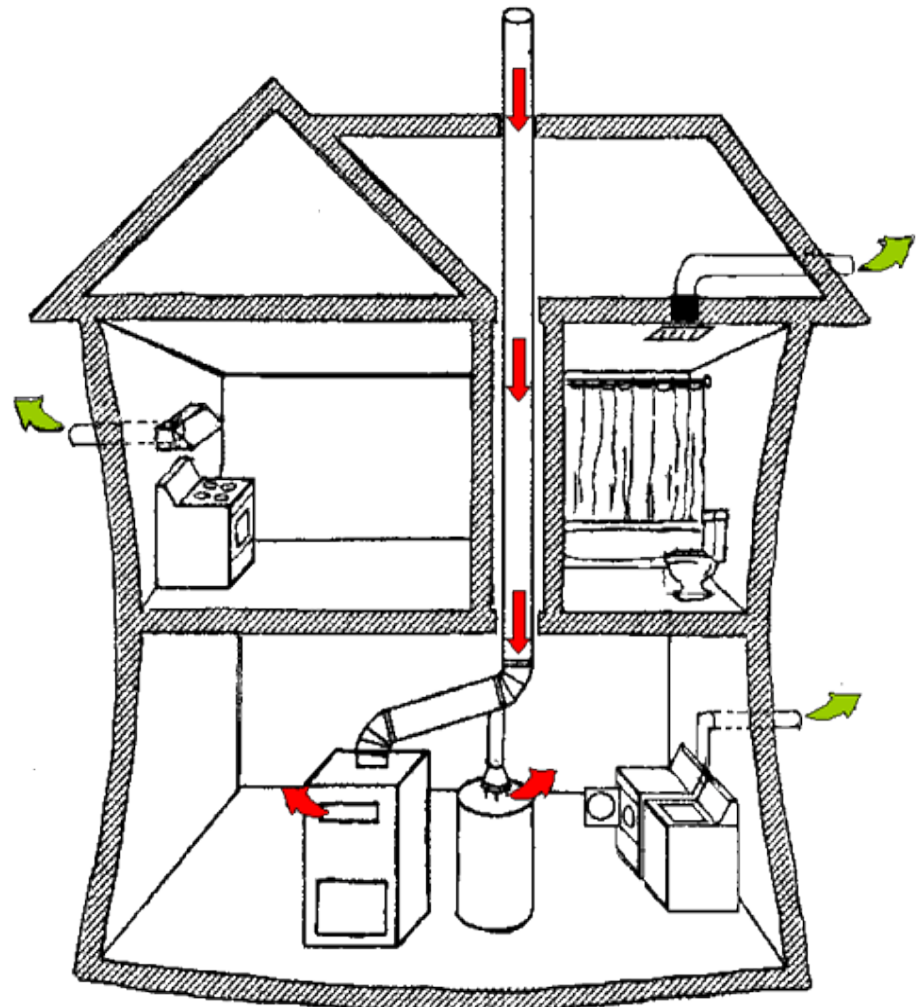
Combustion appliances include:

- Heating equipment
- Water heaters
- Stoves/ranges/ovens
- Gas dryers

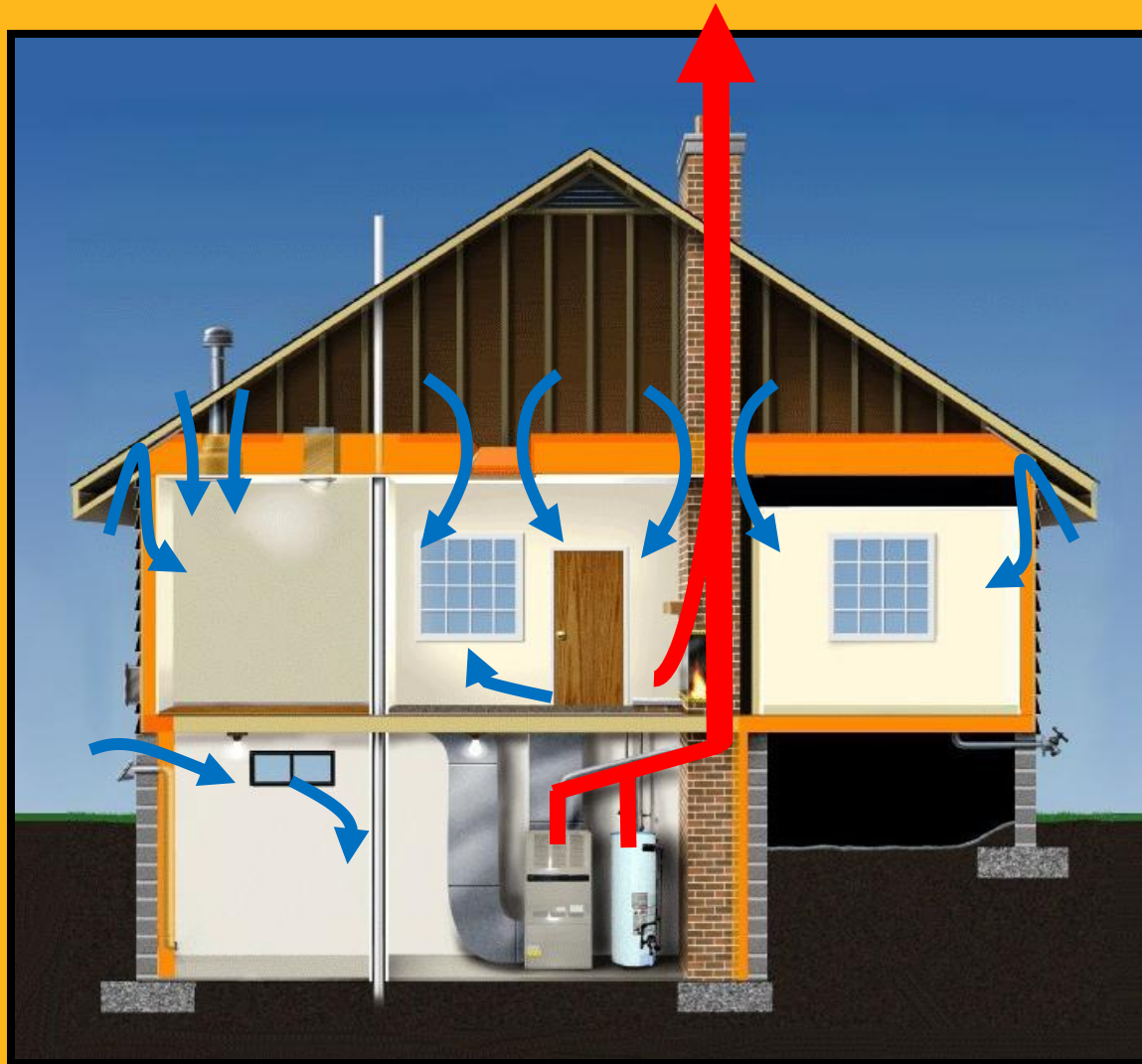


Over-tightening the home can cause problems such as:

- backdrafting
- spillage
- poor combustion efficiency



# Combustion Make-up Air



# Exhaust Gases

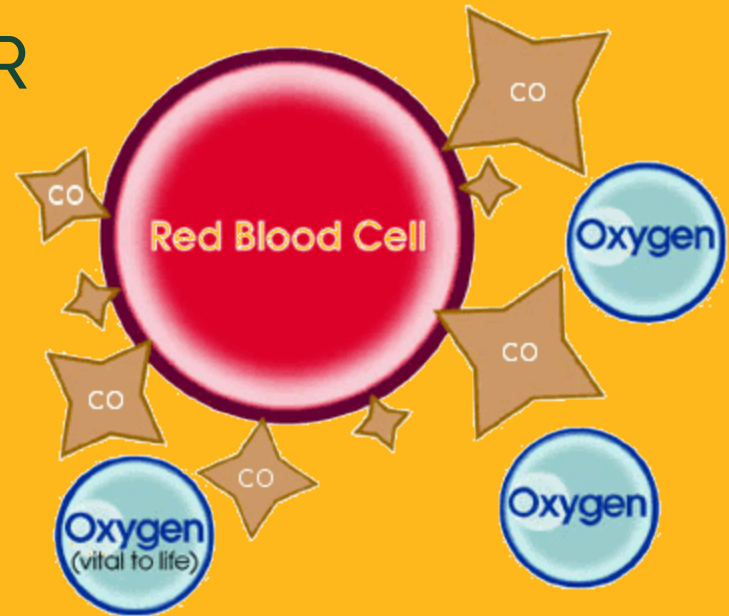
- Combustion mainly creates water vapor and carbon dioxide ( $\text{CO}_2$ )
- Other chemicals present in combustion gases are poisonous:
  - Carbon monoxide (CO)
  - Nitrous and nitric oxide
  - Sulfur dioxide
  - Mercury
  - Particulates



Carbon monoxide  
detector

# Carbon Monoxide (CO) Poisoning

- Causes over 400 American deaths per year.
- Hospitalizes over 4,000
- Sends over 20,000 to the ER
- Symptoms:
  - Light-headedness
  - Nausea
  - Dizziness
  - Headaches
  - Unconsciousness
- If you suspect high CO levels, **GET OUTSIDE!**



# Combustion Safety Testing

- Performed by energy auditors, crew chiefs, and inspectors
- Intended to ensure the home is safe before, during, and after weatherization
- Must be performed on every combustion appliance in every home
- Tests harmful gases, spillage, and backdrafting in natural and worst case conditions



# Common Heating Equipment



Furnace



Boiler



Wood stove

# Common Water Heating Equipment



Gas-fired tank



Oil-fired tank

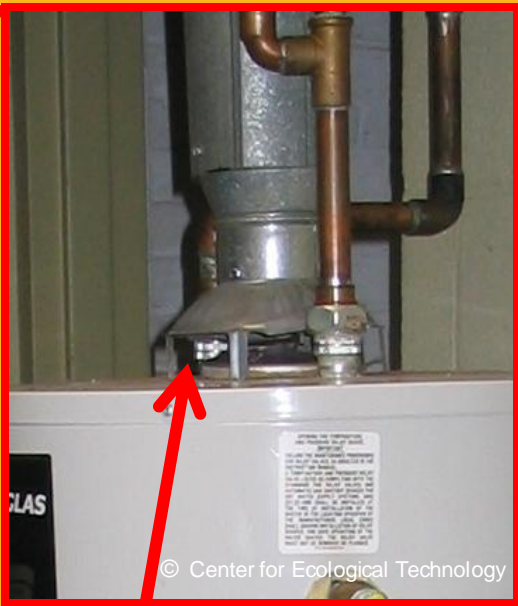


On-demand heater

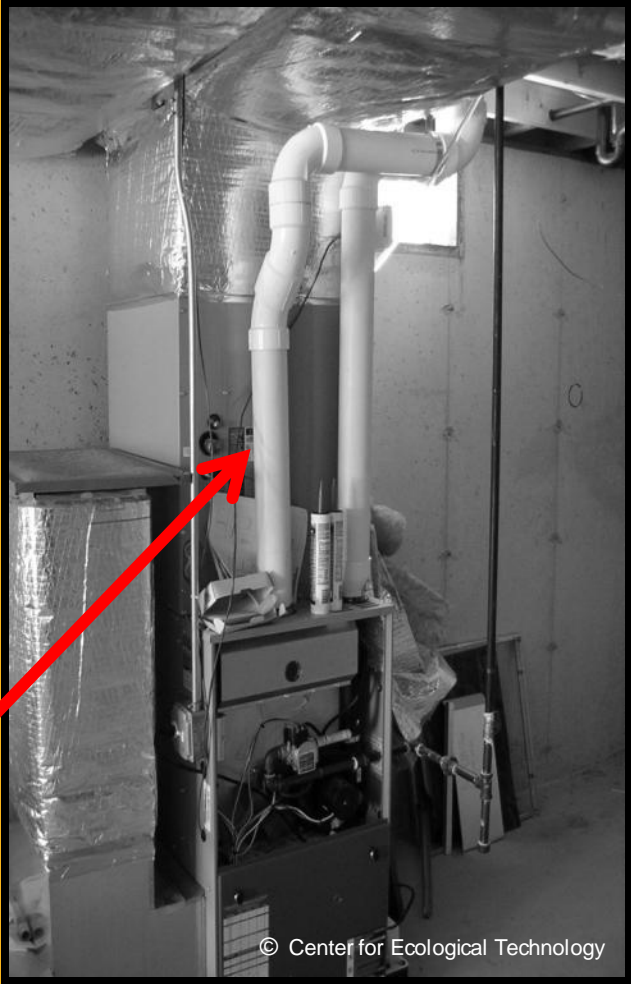
# Natural Venting/Sealed Combustion



Natural draft



Opening  
to flue  
pipe



Sealed  
flue pipe

Sealed combustion

# Warning Signs

## Evidence of Spillage



Water damage



Soot

# Warning Signs

## Poor Flue Arrangements



© Center for Ecological Technology

Long horizontal flue sections



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Poorly fitted flues

# Summary



## Moisture

- can damage buildings
- comes in three forms: bulk, vapor, and condensate
- moves through buildings
- is carried by air
- is measured as humidity in the air
- can encourage mold growth
- is affected by air sealing

# Summary



- Weatherizing buildings can affect the moisture conditions both positively and negatively
- Keep an eye out for potential moisture problems created by weatherization measures
- Existing moisture sources should be addressed when weatherizing the house

# Summary



- Crawlspace can be a significant source of moisture
- Cover dirt floors with 6 mil polyethylene, securing it to the ground
- Seal the covering to ensure permanent placement
- Not installing a vapor barrier can increase moisture problems in the area

# Summary



- Combustion gases are harmful and potentially lethal
- Air sealing can cause combustion equipment to malfunction.
- Stop work if there is no previous combustion safety test information and one cannot be performed at the job
- Know the signs of malfunctioning equipment and raise any concerns to the crew chief
- If you suspect high CO levels, get outside immediately

# Questions

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