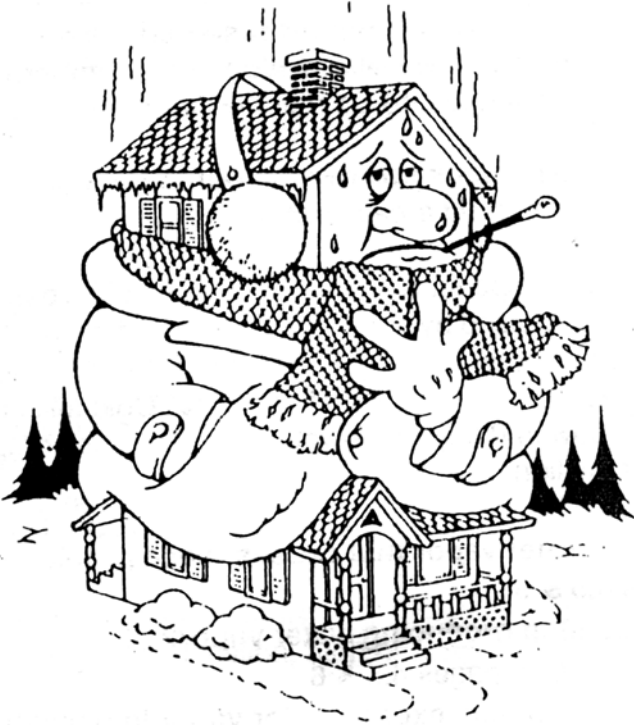


Mold & Moisture: Wet House Guide

Guide to mold & moisture problems and solutions



With appendices and notes discussing important aspects of humidity

- Health considerations of humidity
- Humidity effects on Thermal Comfort and Other Factors of Comfort
- Heating and other humidity-related costs
- Recommendations and cautions

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Mold & Moisture: Wet House Guide

The warning signs that a building has enough water vapor in the air to cause moisture and air quality problems are condensation, steam or frost on interior windows and/or mold or mildew on walls and ceilings. Mold and moisture may also indicate poor indoor air quality.

Six points regarding this condition have to be addressed:

Why do steam, frost, mold and mildew form in a building? Page 1

What problems does moisture cause? Page 2

Where does water vapor that causes these problems come from? Page 3

Why do moisture and pollutants remain in a building? Page 5

How do you stop producing water vapor? Page 5

How do you reduce excess water vapor? Page 5

1. Why do steam, frost, mold and mildew form in a building?

Steam, frost, mold and mildew occur because there is enough water vapor in the air to cause a “dew point,” which is the temperature at which water vapor condenses. When you live in a fish bowl, the sides of the bowl will be wet. See Moisture Chart (back page).

Water vapor condenses in the coldest areas such as on or in:

- Windows
- Pipes
- Ceilings
- Toilet tanks (if the toilet tank sweats during warm seasons, shut off the humidifier during the cold season)
- Uninsulated areas or spots where insulation is missing
- Areas where there is poor air circulation (often occurring in closets, behind furniture and closed shades, and behind goods placed on or against exterior or cellar walls)
- Uneven indoor air temperature sometimes caused by manual or automatic set-back thermostats

A 24-hour fairly constant indoor temperature is recommended.

Much like a thermos bottle, modern buildings are built to be almost airtight and contain all gases, including water vapor. If production of water vapor has been reduced and a moisture problem persists, the building may have too few air changes. Condensation is nature’s sign there may be too few air changes and/or

NOTICE: This paper is written with a heating climate perspective of central New York State, which lies in Ranges 5 and 6 on the Map of DOE’s Proposed Climate Zones. Some points in the discussion about condensation and mold growth in one-to-three story buildings may be universally relevant, considering that condensation and mold are problems worldwide. Other points may be restricted to certain geographic zones.

there may be excessive pollutant gases, including water vapor, present. Stove, furnace and fireplace flames and chimneys act as air pumps. Buildings without these will normally have fewer air changes and more water vapor retention.

DANGER: Operating exhaust fans, clothes dryers or central vacuum cleaners may draw moisture and pollutant-laden air from a furnace, chimney or cellar floor drains into a building, unless there is a supply of intake air such as that from an open window or door.

Are there any cases where condensation is only temporary? Yes. There are primarily three cases:

- New construction
- The beginning of each heating season
- When there are rapid changes in temperature

2. What problems does moisture cause?

A building may have excessive cold weather humidity (30%-50% +) resulting in some of the following:

Health

- Allergies, humidifier fever, Legionella (see appendix 1, Page 8)
- Mold and mildew on interior walls and ceilings
- Dust mites
- Microbial development in standing water
- Moldy odor in basements
- Indoor air quality problems as a result of decreased air changes
- Sick building syndrome symptoms

Comfort

- Feeling chilly

Money

- Steam and frost on windows
- Rotting windowsills or other parts of the structure
- Frost on roof boards or on nails in the attic
- Rising dampness – wet masonry at the base of a masonry wall on grade
- Curling shingles
- Rotting stone, deteriorating slate roof
- Peeling or blistering paint
- Breaking concrete floors and walls
- Ineffective insulation, wet insulation, high heating costs
- Roof cave-in
- Masonry efflorescence
- Bowing trusses, leaking roof
- Mold or moss on roofing and siding, etc.

3. Where does water vapor that causes these problems come from?

Sources of water include:

Climate-caused pressures: Thermal and vapor pressures in buildings change due to outdoor day to day (diurnal) temperature and humidity changes. These are the short-term changes. Seasonal temperature and humidity changes are long-term changes.

Diurnal water gain: High daytime envelope temperature gains caused by solar radiation reduces vapor pressure in the envelope, while low nocturnal temperatures cause increased vapor pressure. These envelope temperature and vapor pressure swings sometimes cause condensation.

Seasonal water gain: Wood is like a sponge. The fabric of a building, the wood, furniture, carpet and clothing, pick up water in equilibrium with the relative humidity (RH) of the surrounding air. In warm seasons the RH is high so the wood gains moisture (up to 5,000 lbs. of water for a 1,200 sq. ft. building). In cold seasons the lower outdoor temperature causes the water vapor to escape from wood into the heated indoor air. The water vapor in the air may then condense in cool areas. Window glass is hopefully one of the coldest objects within the structure. What better place is there for excess water vapor to condense? Condensation from seasonal temperature changes is temporary and should cease after a few weeks of cool/cold weather.

Saturation point: The addition of vapor from a pan of boiling water or a shower will often cause condensation on windows in another part of the building when the air in the building is saturated with water. For this reason, condensation is a discontinuous phenomenon; it appears and disappears as the living style of the occupants change.

In the basement, water vapor and other pollutants may come from:

- Defective furnace, water heater or chimney pipes
- The discharge from a condensate furnace
- Plugged chimney or chimney spillage due to negative air pressure in the building
- Below-grade basement wall or floor—these should be waterproofed
- Dirt floor, cracked concrete floor—cover floor with one layer of 4 to 6 mil polyethylene plastic
- Water in sump pit or in a cistern—cover with a piece of plywood or with one layer of 4 to 6 mil polyethylene plastic
- Underground drainpipe that allows air to enter the space
- Humidifier or laundry tub with standing water
- Clothes dryer or clothes drying on a line
- Firewood stored in the cellar and rotting wood. One face cord weighs approximately 1,000 lbs. dry, up to twice as much wet, and when freshly cut, contains up to 120 gallons of water

- Water vapor, radon and other gases from the surrounding soil may be added by having:
 - Hot stove or furnace close to below-grade wall or floor
 - Heated floor on grade
 - Uncapped block walls—cap them with cement or foam insulation
 - Water draining from condensate furnace, dehumidifier or air conditioner onto or under the concrete floor

Note: Faulty furnaces may cause serious problems—even death!

All smoke contains water vapor, a by-product of burning fuel. Kerosene and fuel oil produce over one gallon of water for each gallon of fuel burned. Natural gas produces 1.1 gallons of water for each 100 cu. ft. of fuel burned; coal and wood also produce water vapor. The water vapor produced may amount to as much as 3 or 4 gallons of water for a 2,000 sq. ft. house each winter day in the temperate zones of the world. Water vapor from furnaces and stoves is normally removed through smoke in a chimney. Modern condensate furnaces often condense this vapor and drain it into cellar drains or sometimes into a simple hole in the concrete floor. This may contribute to excessive humidity in a building.

In living quarters water vapor may come from:

- Unvented open flames such as those from a gas stove, gas oven, kerosene heater or ductless water heater (1.1 gallons per 100 cu. ft. of gas or gallon of fuel consumed)
- Occupants (up to 1 gallon of water per person per day)
- Cooking
- Shower, bath, hot tub, Jacuzzi or swimming pool
- Fine spray or aerated showerheads, including some energy-saving showerheads. These may require more time to shower and the water must be hotter for comfort
- Dishwasher, soaking laundry or soaking dishes
- New occupants (babies, retirees, or visitors)
- Vaporizer, humidifier or floor mopping
- Plants, fish tanks, leaking pipes or greenhouses
- Water vapor may also be added to the air in a house by use of:
 - Exhaust fan
 - Central vacuum cleaner
 - Furnace or clothes dryer

In the attic condensation may come from:

- Power attic ventilators drawing air from heated spaces below—close all air leaks
- Chimneys vented out the side of the building below a vented attic, allowing fumes and vapors from the furnace to enter the attic through soffit vents

Solar Heating Considerations

Hot air is thirsty air. High air temperatures cause vapor accumulation in warm rooms, partitions, and attics. When these areas cool, the vapor condenses.

In garages, water may come from:

- Wet automobiles
- Wet clothes
- Snow-covered toys and tools
- Grade-level floor
- Firewood

Outdoors, water may come from:

- Improper grading—have a 6 inch drop in a 10 foot run away from the house
- Rising damp, poor flashing, porous siding or roofing
- Outdoor air in the summer
- Leaking roof, precipitation
- Solar-heated masonry, wood siding or roofing
- Enclosed porch or attached garage
- Wind-driven rain or solar drive. Solar drive occurs when the exterior cladding materials are moist and the rays of the sun increase cladding and enclosure temperatures, causing moisture to be drawn into the heated areas

4. Why do moisture and pollutants remain in a building?

Because there is or are:

- Water vapor-tight siding
- Water vapor-tight roofing
- Vapor retarders in the walls
- Vapor retarders in ceilings, including vapor retarders which are cut, sliced or perforated
- Storm windows and storm doors
- Weather-stripped doors and windows, and increased insulation
- Closed doors and windows
- Closed damper in a fireplace
- Stack damper in a chimney
- Vines and shrubs close to the building
- Waterproof attic floors such as those made from plywood or waferboard
- Fewer door openings and closings due to decreased traffic in a building (fewer children, cats, and dogs)
- Decreased movement of air in wall cavities between floors of a building

Flames and chimneys in stoves, furnaces and fireplaces act as air pumps. Buildings without these will normally have fewer air changes, therefore more humidity retention.

5. How do you stop producing/eliminate excess water vapor?

Primary control measures must concentrate on identifying and reducing the sources of dampness.

Natural Solutions to reduce water vapor (Green venting):

Passive (Green) solutions are desired because they require less maintenance and less energy. To reduce problems caused by excess water vapor, consider all of the following ventilation directions, and decrease the unnecessary production of water vapor and interior temperature swings.

Ventilation Directions (assuming an airtight ceiling and porous insulation):

- Close all air leaks in the ceiling, then ventilate the attic with a ratio of one free inch of ventilation per sq. ft. of attic floor space with balanced ventilation, 50% at the peak and 50% at the soffit. Use ridge vents with exterior wind baffles to deflect wind to draw air out to the ventilated space below. (Neither ridge vents nor soffit vents alone will suffice.)
- Ridge vents and soffit vents in combination are usually the best choice for attic ventilation
- At least one inch of open space in the soffit, the full length of both sides of the building, as well as two inches of space at the peak of the building, is needed for effective ventilation
- 16" x 18" mesh screen covering openings impairs their value. (Do not use vents or vent screens with holes smaller than 1/8" square.)
- End vents or gable vents are not effective unless there is a constant wind blowing in the same direction as the ventilators
- Vents on two levels of the same roof may allow snow and water intake problems in the lower of the vents
- Vent the roof of all attached porches, rooms and garages in a similar manner to the ventilation on the roof of the house, as long as the attics are not connected
- Attic fans are ordinarily less effective than adequate passive ventilation
- Keep exterior siding temperatures as close to exterior air temperatures as possible by ventilating behind the siding. Have non-porous siding finished in a non-heat-absorbing, reflecting (light) color on the east, south and west sides of the building to reduce solar heat and moisture gain.

Remove the ceiling vapor barrier to allow vapor out of the heated areas into the ventilated attic. Cutting or slicing a vapor retarder is not adequate. Water vapor will condense in insulation unless there is free movement and adequate ventilation.

An alternative, short-term solution to remove excess moisture is to open two windows, 1/2" + - and storm windows in warm rooms during cold seasons (October through April), until the water on other windows in the building disappears.

Opening a window will not necessarily increase the heating expense. By opening windows, water, which is the most expensive compound to heat, will leave the building, thereby lowering heating expense. Opening windows may be less expensive than using a dehumidifier, especially during cold seasons.

Mechanical solutions:

- Dehumidifiers remove water vapor, but are less efficient in cold areas than in warm areas. Install them as close to the ceiling as possible and clean them often. Dehumidifiers do not remove other indoor pollutants

- Exhaust fans remove some water vapor, but they may bring furnace fumes, sewer gas, and ground gas into a building. (Studies have found that exhaust fans are seldom used in cold seasons.)
- Energy Recovery Ventilators (ERV) (HRV) (AAHX) may sometimes provide workable, but not necessarily economical, solutions to moisture problems. Each mechanical device requires maintenance, frequent cleaning, almost constant operation in cold weather, occasional replacement and energy use for operation.

Humidifying air in a house may be costly

Consider the following about humidifiers:

- Humidifiers may be sources of disease
- Water from minerals and biologicals such as lead, trihalomethanes, chlorine and trichloromethanes in water are dissipated by humidifiers
- Excessive humidity in the air may cause mold, mildew and microbe growth, which in turn may cause allergies and illnesses
- Humidified buildings may have higher energy costs
- When water vapor moves from warm areas to cold areas it may cause condensation, exterior paint peeling, curling shingles, spalling concrete and other concerns
- Humidifiers require cleaning weekly, at a minimum
- Humidifiers require electricity to operate

Consider the following questions about humidity:

- Are humidified houses healthier for the occupants?
- Are the occupants of humidified buildings more comfortable than occupants of non-humidified buildings?
- Does high humidity control static electricity?

Physicians sometimes suggest fumigation to reduce mold, by using saucers of formaldehyde, Clorox or Lysol placed in a building. While fumes from these may help reduce mold growth in the home, they will also degrade indoor air quality.

Studies have found that students in humidified schoolrooms have fewer colds in the cold weather. However, some experts question these studies. There are few, if any, definitive studies which show that the general population is affected adversely by viruses or microbes in either high-or low-humidity areas, although high relative humidities have been found to facilitate cross-infection.

On the other hand, there are innumerable studies that show the problems inflicted on many in the general population by indoor mold, dust mites, and other by-products of condensation. Thousands of people are diagnosed as allergic to by-products caused by indoor condensation, while many other victims are suspected.

Mold and mildew develop when there is condensation. Many houses have a relative humidity of 50% at 70° F in the living room (warm room),

which at 52° F in the cellar (cold area) amounts to an RH condensation of 100%. Condensation is responsible for mold growth. Mold in the cellar may be responsible for mold spores in the air of the entire structure. Again, remember that water vapor, gaseous pollutants and mold spores will travel throughout a building as quickly as cooking odors.

Humidifiers require frequent cleaning after short periods of use.

While not encouraging the use of humidifiers, the National Jewish Center for Immunology and Respiratory Medicine in Denver has published recommendations for maintaining humidifiers and vaporizers, which include weekly cleaning for constant users and daily cleaning when respiratory infection may be present. Their extensive cleaning directions call for cleaning with detergent, thorough rinsing with tap water, rinsing with vinegar and then rinsing again with clean tap water.

Contaminants and bacteria like Legionella, which may infect water supplies, may be spread into indoor air by the aerosol action of a humidifier. Humidifiers are known breeding grounds for pneumonia-type viruses. Unfortunately, anti-bacterial agents added to humidifier water also become airborne, further degrading the quality of indoor air.

A study done in 1994 suggests that the presence of home humidifiers is strongly associated with increased respiratory symptoms. Studies done by scientists from the United States, Japan, and Canada concluded that, "It is then highly probable the presence of mold, dampness, and related conditions in homes are contributing to morbidity."

Dehumidifiers

Dehumidifiers have essentially the same mechanics of operation as humidifiers. Little is written about their maintenance, but common sense would dictate the same prudent care and cleaning of dehumidifiers as humidifiers. There are few if any studies that attribute disease to dehumidifiers, although, like humidifiers and air conditioners, dehumidifiers circulate indoor air through coils, clean or unclean. Air conditioners, much like humidifiers, must also be suspected sources for Legionnaires' disease.

Appendix 1

HEALTH ASPECTS OF HUMIDITY:

Dust Mites

Dust mites are more abundant in damp houses where the allergen count may be higher, up to fifteen per sq. ft. Beds, and often the bedroom in general, have a higher relative humidity than other areas of the house. Methods of controlling dust mites include airing out the bedroom, vacuum cleaning the mattress, buying a new pillow yearly, putting the pillow in the clothes dryer for a short while, warming or cooling the pillow outdoors, and keeping the RH in the house below 35% for an extended period each year.

Pollen Allergies

Studies show that pollen allergies are reduced at relative humidities under 40%. Dehumidifying or air conditioning the indoor air may help to maintain lower pollen allergy symptoms.

Viruses and microbes grow in all humidity ranges. Some microbes and viruses thrive in the dampness of the summer weather, while others thrive in the dry heating seasons of the fall and winter. Each microbe grows best in its own microclimate. Methods of controlling mold and microbe growth in damp buildings include dehumidifying, or the use of biocides or fungicides. However, the latter are known to contribute to poor indoor air quality.

Fumigant Effects

Kerosene heaters and gas stoves, among other internal heating devices, give off numerous gases, e.g., carbon monoxide, nitrogen dioxide, etc. Some of these may have a fumigant effect on the quality of indoor air. There are few studies that examine the possible fumigant effect of the by-products of these heaters and stoves. Extreme caution is advised when using any of these products.

Water in urban water systems is often purified by the use of chlorine and/or other possibly toxic chemicals. There has been little research done on the fumigant effect of gases from treated water supplies or their contribution to the existence of molds and microbes in the indoor air.

Formaldehyde

Many building products contain formaldehyde. Formaldehyde is considered a health hazard for some people. It has been found that the amount of this compound in the air often increases in direct proportion to the water vapor content in the air. In addition, formaldehyde fumes in the air combine with chlorine gas originating from showers, baths or humidifiers, producing phosgene gas. Phosgene gas is a toxin and considered a health hazard. Lowering the relative humidity in a building may decrease the concentration of formaldehyde vapors.

Appendix 2

COMFORT

Thermal Comfort and Other Factors of Comfort

There are various aspects of damp, wet or dry buildings that affect occupant comfort. Thermal discomfort is feeling too dry, too wet, too cold, too hot, etc., related to the climate in the building if the humidity is too low. Dry mucous membranes and skin are common discomforts caused by dry air. Static electricity may cause uncomfortable shocks: while not dangerous, they are a nuisance. Odor perception, which varies with humidity, also affects comfort because it directly affects the senses.

Thermal Comfort

Factors determining indoor thermal comfort include:

- Air temperature
- Air velocity
- Radiant temperature
- Vapor pressure/relative humidity
- Occupant activity level
- Clothing

Special thermal comfort problems include:

- Drafts
- Cold or hot floors
- Non-uniform clothing
- Uneven floor/ceiling temperature differential
- Large variations in temperature

This list of thermal comfort factors indicates that vapor pressure/relative humidity in the air is the fourth most important factor after air temperature, air velocity and radiant temperature. The order of comfort factors has been established after extensive worldwide research. At regular indoor cold weather temperatures below 76° F, it has been found that relative humidity levels below 60% are indistinguishable.

A 1975 Swedish study of over 600 office workers found that the number of complaints of dry air were the same in humidified office buildings as in unhumidified buildings. There was no evidence that increasing relative humidity decreased complaints.

Moisture evaporating from clothes causes a chill when a person goes from a high humidity building to the cold outdoor air. Shops and stores may be advised to keep cold weather humidity low so customers won't feel chilled when leaving a building. Water has high thermal conductivity. For example, if a person falls out of a boat into the cold North Atlantic water, the cold water will draw out body heat, causing freezing death within a short time.

Some occupants of homes with relative humidity levels over 60% find that they are chilled at temperatures up to 80° F. The high thermal conductivity of the moist air, clothes and skin may account for this. Lowering indoor humidity may cure this situation more effectively and less expensively than raising temperatures.

Other Factors of Comfort

Dryness

Dry mucous membranes in lips, congested nasal airways, cracked skin, and dry coughs are other aspects of indoor health and comfort that have not been carefully examined in indoor air quality studies. Many people suffer from these common winter afflictions that cause inconvenience as well as discomfort. Some people believe that dry mucous membranes allow microbes to enter the bloodstream through the broken skin. The most common, but not necessarily the most

effective, solution prescribed by many professionals for these dryness problems is humidifying indoor air.

This sounds like a good solution but may not be effective. Actually, vapor pressure differences between the outdoor cold weather air and the human body might often be much greater than summertime differences. The human body should be much thirstier in cold seasons than it is in warm seasons. The common winter drinks of coffee, tea, and alcohol have a diuretic action on the body compared with the common summer drinks of soft drinks, lemonade and water. Drinking fewer diuretic drinks may help cold weather comfort. Drinking more water might also improve the dryness problem.

Skin and nasal passage dryness may be aided more by prescribing increased water consumption than by humidification of the indoor air. Airlines require that airborne personnel drink a glass of water, and only water, every hour while flying, to overcome the extreme drying effect of low humidity due to pressurized cabin air.

Similarly, the human body manufactures oils that appear to protect the body and the skin from the surrounding elements. A search of literature reveals little to support the habit of daily bathing and the use of soap and other agents to "clean", "dry", "moisten", "deodorize", "protect", and "color" the skin. Over-cleaning the skin removes natural oils, causing dryness, which then must be "remedied". Humidifying the air has been found to be unproductive for increasing wintertime "thermal" comfort, and there is little evidence to support health claims.

Odor perception

When the odor-generating source is independent of water vapor, odor perception decreases as the relative humidity increases. Cooking and smoking are two such sources. Odor generation intrinsic to relative humidity, such as paint odors, linoleum odors, and formaldehyde vapors, increases as the relative humidity increases.,

Static electricity

Static electricity is definitely reduced when the relative humidity is about 30%. Static will be practically nonexistent in buildings with a relative humidity of over 40%. However, there is little to show that static electricity is anything more than a nuisance, except to computers and other electronic devices. (Computers are sometimes adversely affected by static shock.)

Appendix 3

EXPENSE

Energy expense

Water is very difficult to heat. It has a specific heat of 1.00, while dry air has a specific heat of 0.25. This means that it takes four times as much energy to heat one pound of water as it does to heat one pound of dry air. This is clearly illustrated in many churches across the country every weekend. Churches with high

relative humidity take all Saturday afternoon and evening to heat up enough for the parishioners' comfort on Sunday. This need for a prolonged heating period is partially due to the suspended water molecules in the air that are slow to heat. Low vapor content air heats more rapidly than high vapor content (humid) air. Opening doors and windows for a while when the heat is first turned on might speed up the process of heating the building.

The high thermal conductivity of water is also responsible for the transport of heat out of damp buildings. Thermography is the science of taking photographs with the use of heat-sensitive film. It shows heat escaping the building where there is no insulation or where insulation or other parts of building fabric are wet. Because water is expensive to heat, it can be concluded that a building with low humidity should have lower energy costs. Water is also expensive to cool.

Humidifiers are expensive to operate. Dehumidifiers, which are similar to air-conditioners and refrigerators, are also expensive to operate. Buildings are like sponges. Humidified buildings are often kept close to the fiber saturation point (as witnessed by the condensation which readily appears in them). Buildings that are humidified often also require dehumidifiers to lower the humidity during seasons with high condensation. Energy use for humidification and dehumidification add to the overall energy expense and increase a building's carbon footprint.

Maintenance expense

The building with condensation problems may not have enough air change, and will therefore retain airborne pollutants, as well as water vapor. On the other hand, the building without condensation problems may have excessive air change, resulting in an increase in energy expenses. The best solution is to avoid either extreme. Not included in this study are cement blocks, sometimes used in the construction of basement walls. When not painted or pargeted, they are extremely porous and can be the cause of serious air and heat loss.

Appendix 4

RECOMMENDED COLD WEATHER RESIDENTIAL HUMIDITY LEVELS: *
(Rowley, Algren et al. 1941).

For a house at 70° F

When the outdoor
temperature is:

Recommended humidity levels:

-20° F or below	not over 15% RH
-20° F to -10° F	not over 20% RH
-10° F to 0° F	not over 25% RH
0° F to 10° F	not over 30% RH
10° F to 20° F	not over 35% RH
over 20° F	not over 40% RH

* To reduce steam or frost on single pane windows.

Higher is not better

Cold weather relative humidity between 30% and 50% may provide all-around ideal conditions for most occupants. Periods with RH levels as low as 10% occasionally fluctuating between 15% and 30% are tolerable for most occupants in spite of occasional static shocks. Cold weather residential humidity levels above 30% are not usually necessary for thermal comfort and have been found not to be beneficial for the health of occupants.

Nordic standard for humidification

The Coordinating Committee for the Central Building Committee for the five Nordic countries, Denmark, Finland, Iceland, Norway and Sweden, has made the following statement concerning humidification, which might well pertain to all cold weather areas of the world (4):

“In light of present knowledge, general humidification of air is seldom necessary. A lot of problems associated with dry air can be remedied by humidification when relative humidity (RH) is less than 20%. From the hygienic point of view, general humidification of air is not recommended.”

On the other hand, The American Society of Heating, Radiation, and Air Conditioning Engineers (ASHRAE) has specified year-round humidity levels to be in the 30%-60% RH range.

A humidity gage is not necessary. Mold on the walls or ceiling, or steam or frost on the warm side of a double-pane window, signifies that a house has more than enough water vapor in the air. A building with lower humidity should have lower heating costs because water is the most difficult substance to heat, and additionally has high thermal conductivity. High thermal conductivity causes heat to leave damp buildings faster than it does dry buildings.

ASHRAE recommends that no energy be used to humidify above 30% RH in the winter. It also states that no energy be used to dehumidify below 60% in the summer.

This Wet House Guide summarizes a paper presented at the Thermal Performance of the Exterior Envelope of Buildings II conference on Energy Conservation and the Building Envelope sponsored by the United States Department of Energy and the American Society of Heating and Air-Conditioning Engineers in Las Vegas, NV, December 9, 1982.

Humidity Table

Pounds of water per 100 pounds of dry air at different temperatures and relative humidities.

100 pounds of dry air equals 1,333 cubic feet of dry air at 70° F. This is equal to the amount of air in a room 11 feet wide, 15 feet long, and 8 feet high.

AIR TEMPERATURE In Degrees F	RELATIVE HUMIDITY PERCENT							WALL OR WINDOW TEMP
	100%	80%	60%	50%	40%	30%	20%	
160° F	22.90			15.00				
150° F	22.00			11.00				
140° F	15.00			7.50				65°F
130° F	11.00			5.50				60°F
100° F	4.30	3.50	2.60	2.20	1.70	1.20	0.87	55°F
90° F	4.10	2.50	1.90	1.60	1.20	0.93	0.62	45°F
80° F	2.20	1.60	1.40	1.20	0.90	0.68	0.45	Note:
70° F	1.60	1.30	1.00	0.83	0.65	0.48	0.32	Lines
60° F	1.05	0.86	0.65	0.54	0.42	0.32	0.21	indicate
50° F	0.78	0.62	0.47	0.39	0.31	0.23	0.15	Dew point
40° F	0.53	0.42	0.33	0.27	0.21	0.16	0.11	on cool
30° F	0.35	0.28	0.22	0.18	0.14	0.10	0.07	surfaces
20° F	0.24	0.19	0.15	0.12	0.09	0.07	0.05	at these
10° F	0.17	0.13	0.10	0.08	0.07	0.05	0.03	temperatures.
0° F	0.11	0.09	0.07	0.06	0.04	0.03	0.02	

Using The Chart

The lines indicate the Dew Point, the temperature at which water condenses. For example, moisture appears on the wall or window whose temperature is 55° F when the adjacent living area has a 70° F air temperature and 50% relative humidity (RH).

Humidity Note:

One shower adds one pound of moisture to the air. This is enough to make air foggy, even very dry air below 65° F at 31% RH (average for a house), or 80° F air at 50% RH (typical of a bathroom).

Hot Air Is Thirsty Air:

Example: Cold air holds less moisture (absolute humidity) than warm air. Although its relative humidity may be high, it will pick up much more vapor when warmed, and still be at the same or lower relative humidity.

At 70° F, a building with a relative humidity (RH) of:

- 30% will cause condensation to form on surfaces at 38° F.
- 40% will cause condensation to form on surfaces at 43° F.
- 50% will cause condensation to form on surfaces at 53° F.*

*This temperature may be found in below-grade areas in buildings in climate zones 5, 6 and 7.