

Chapter 2

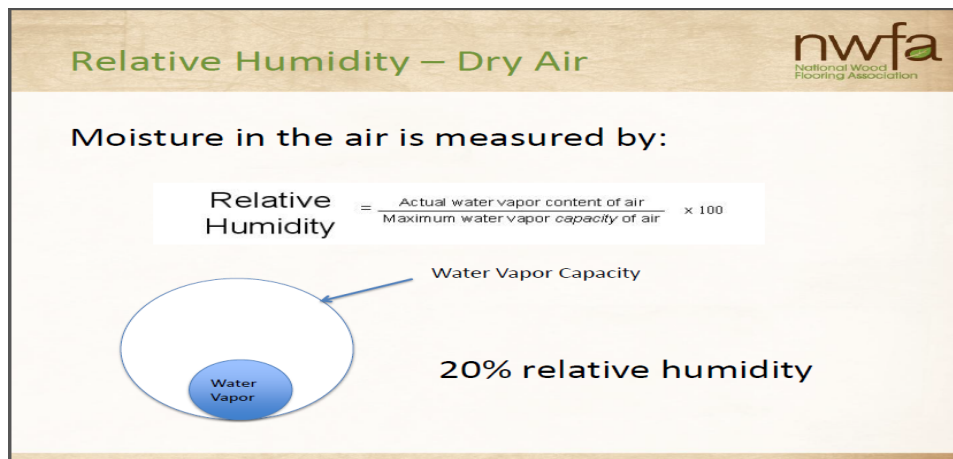
[Understanding Relative Humidity](#)

Recently I was fortunate enough to attend a National Wood Flooring Association seminar entitled “Understanding Relative Humidity in Your Home”. The seminar was very informative and I will share the information with you.

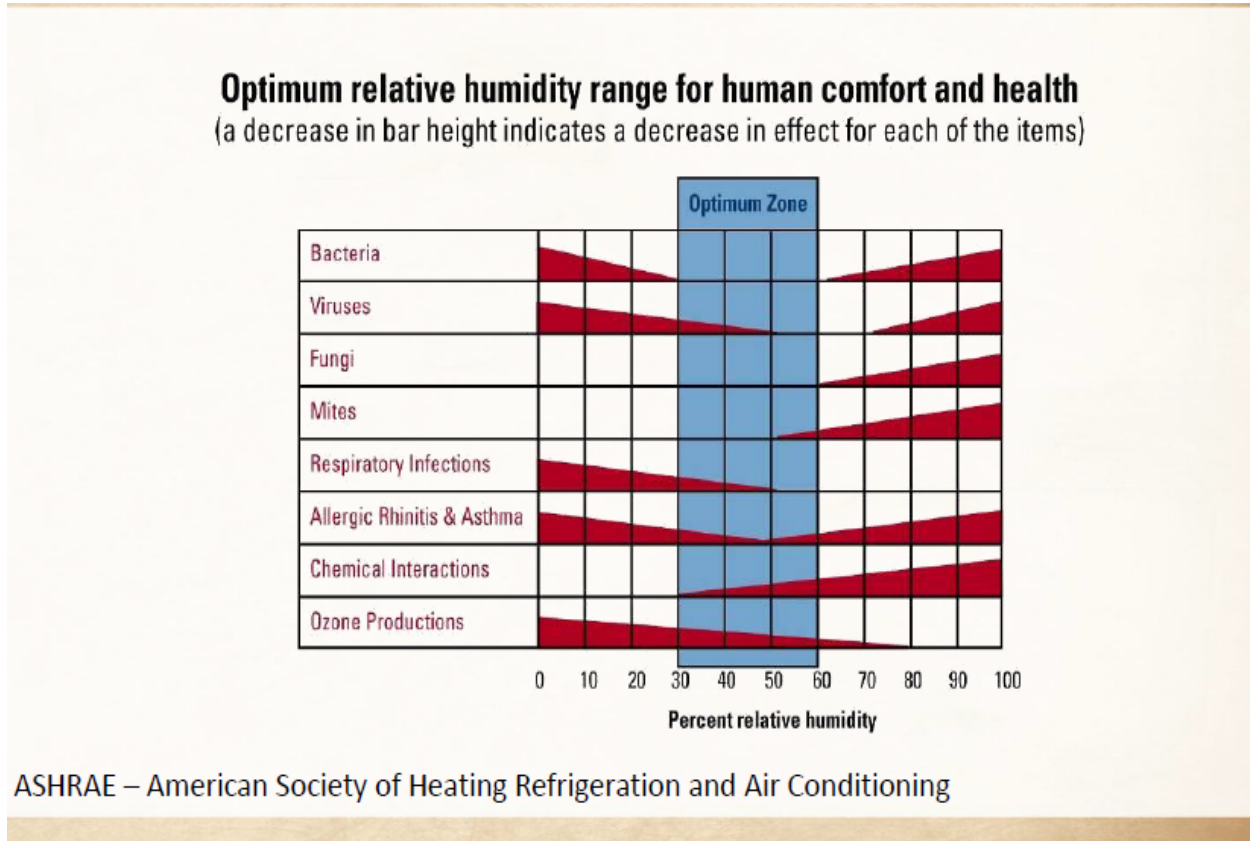
Being in the Northeast Region, we are exposed to extremely cold dry winters and very humid summers. Without any humidity control, the same house with extreme [spaces between the boards](#) in the heating season, could become [cupped](#) in the high humidity of the summer.



Water vapor is a gas, it will fill any space; however, other forces such as air movement, due to temperature stratification, have a strong effect on the dispersion of humidity. Normal living conditions are considered 65-75 degrees Fahrenheit (18-24 C) with a relative humidity between 30-50%. This is the range that is best for your health which is also best for your wood flooring.



The Human Health chart, pictured below, clearly shows the effects of below 30% and above 50% Relative Humidity for bacteria, viruses, respiratory infections, allergic rhinitis and asthma problems. If you have pets, and let your RH get above 50%, it is almost certain that you will have dust mites. Although not visible they are there feeding daily on flakes of skin from humans and pets.



Signs of dust mites include sneezing, runny nose, and signs of asthma such as wheezing and difficulty breathing. They cannot exist in humidity levels below 50%. A study in 2000 found that more than 45% of American homes had detectable dust mite levels associated with the development of allergies, and 23% had bedding with concentrations of allergens high enough to trigger asthma attacks. I am getting itchy just thinking about these creatures.



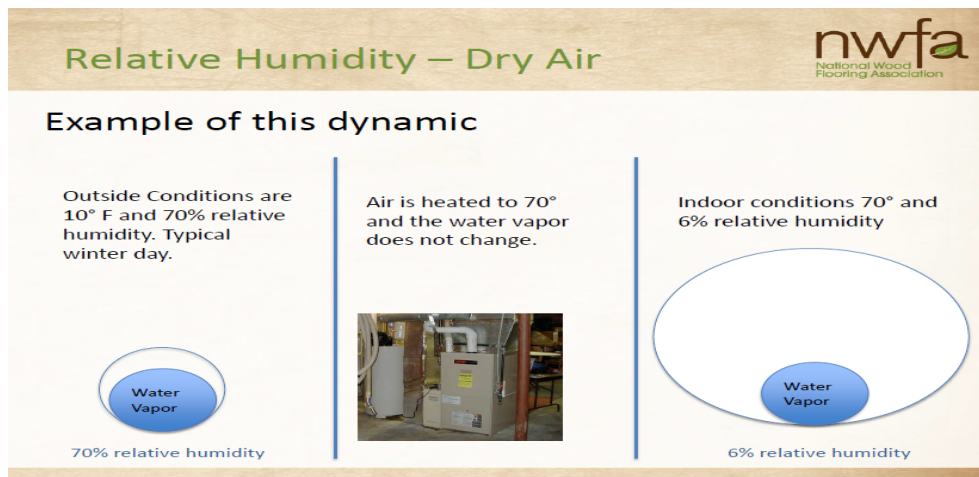
In the past, I was only concerned with the humidity levels inside the home because that is where our product would be, I just assumed the outside air came inside and became inside air. What I did not realize was the amazing effect temperature has on humidity and as a result, hardwood flooring. The upcoming illustrations will make this much easier to understand.

MOISTURE CONTENT OF WOOD																				
AT VARIOUS TEMPERATURES AND RELATIVE HUMIDITY READINGS																				
Temperature (°Fahrenheit)																				
30	1.4	2.6	3.7	4.6	5.5	6.3	7.1	7.9	8.7	9.5	10.4	11.3	12.4	13.5	14.9	16.5	18.5	21.0	24.3	26.9
40	1.4	2.6	3.7	4.6	5.5	6.3	7.1	7.9	8.7	9.5	10.4	11.3	12.4	13.5	14.9	16.5	18.5	21.0	24.3	26.9
50	1.4	2.6	3.7	4.6	5.5	6.3	7.1	7.9	8.7	9.5	10.4	11.3	12.4	13.5	14.9	16.5	18.5	21.0	24.3	26.9
60	1.3	2.5	3.6	4.6	5.4	6.2	7.0	7.8	8.6	9.4	10.2	11.1	12.1	13.3	14.6	16.2	18.2	20.7	24.1	26.8
70	1.3	2.5	3.5	4.5	5.4	6.2	6.9	7.7	8.5	9.2	10.1	11.0	12.0	13.1	14.4	16.0	17.9	20.5	23.9	26.6
80	1.3	2.4	3.5	4.4	5.3	6.1	6.8	7.6	8.3	9.1	9.9	10.8	11.7	12.9	14.2	15.7	17.7	20.2	23.6	26.3
90	1.2	2.3	3.4	4.3	5.1	5.9	6.7	7.4	8.1	8.9	9.7	10.5	11.5	12.6	13.9	15.4	17.3	19.8	23.3	26.0
100	1.2	2.3	3.3	4.2	5.0	5.8	6.5	7.2	7.9	8.7	9.5	10.3	11.2	12.3	13.6	15.1	17.0	19.5	22.9	25.6
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	98
	Relative Humidity (percent)																			

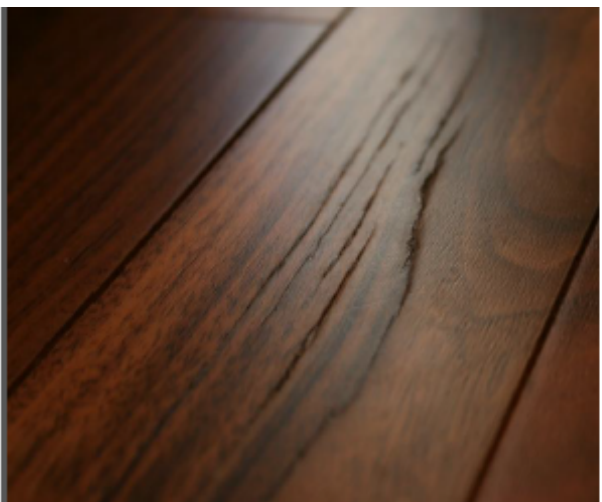
Chart taken from *Wood Handbook: Wood as an Engineering Material*, (Agriculture Handbook 72), Forest Products Laboratory, U.S. Department of Agriculture.

Too Dry

The below slide is a typical winter day with an outside temperature of 10 F (-12 C) and RH of 70%. When this air enters the house and is heated to 70 F (21 C) the RH drops to a shocking 6%. As I am writing this article I see the outside temperature is -11 F (-24 C) which would make the RH of the reheated air almost nothing. As the temperature drops your heating system is running more frequently which makes it impossible to keep your humidity between our 30-50% without adding moisture to the environment.



Long stretches of cold weather and not adding moisture back into the house is not only damaging to your solid or engineered hardwood flooring but it effects all wood products and any wood products attached to them such as crown moulding, baseboard, countertops, cabinet doors, etc. Some examples are the pictures below:



Removing nearly all the moisture from the wood can stress the wood beyond its limitations especially the poor quality engineered wood manufactured offshore. Some situations where boards have shrunk and developed spaces will correct themselves when moisture is added back into the home.

Household Moisture




Table 2: Household Moisture
The following naturally add to the indoor environment:

Source	Estimated amount (pints)
Bathing	0.12 per standard-size bath
Showering	0.52 per 5-minute shower
Cooking	2 per day
People (4)	0.44 per hour
Plants (5-7)	0.9 per day
Cleaning	2 per day
Dishwashing	0.9 per load
Average household	0.75 per hour

ABOUT 15% OF MOISTURE NEEDED IN A COLD CLIMATE

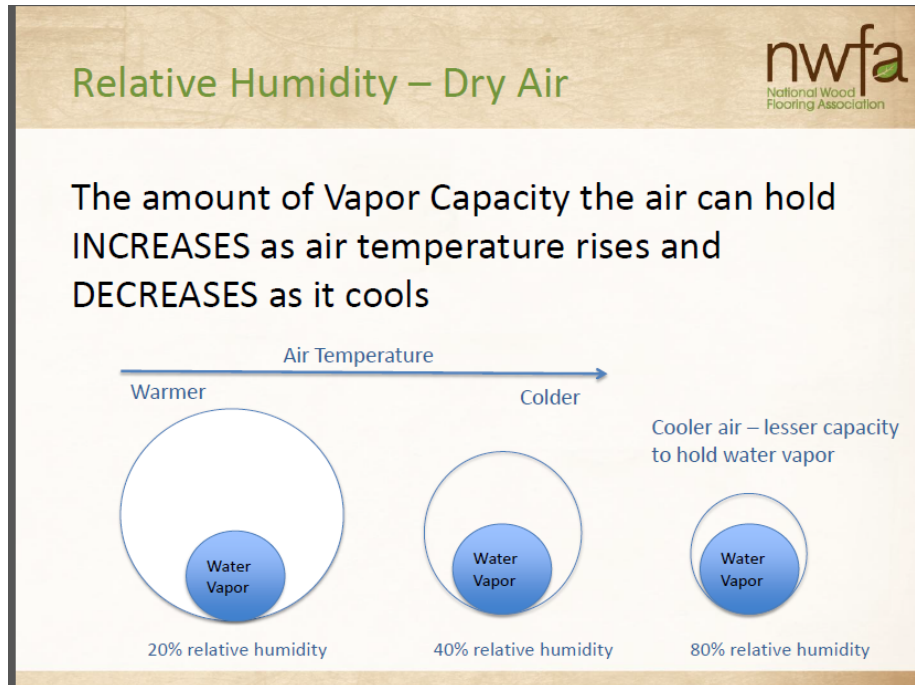
Other issues such as cracks in the boards or caulking that has separated will not usually correct themselves. When manufacturing our products, we must consider the movement of the wood as well as the movement of the finish. With our engineered flooring we must consider three products that must move together, the plywood, the wood and the finish. Inside the 30-50% RH normal minor issues may occur, but the further outside of the preferred RH range the more problems are almost certain to occur. Wood will behave like wood.

Will Wood React Any Differently?




Too Wet

We have spent most of our time talking about cold air being heated and RH dropping. When warm humid air is cooled the RH rises 2.2% for each 1 degree Fahrenheit. In a crawl space, the moisture comes from two sources; the ground and the outside air. The soil will wick moisture, through capillary action, from moist to dry areas. Water does very little to ruin a home with a dirt crawl space as it seldom touches any of the joists, sill plates, girders or insulation. It is the water vapor that causes the wood to mold and rot. Condensation makes everything wet which will stimulate mold to grow and wood to rot.



Crawl spaces are typically dark, damp and cool. We will look at an example of a typical summer day in the Northeastern region. Outside air at 80F degrees with a RH of 70% enters into a 64F crawl space. Let's look at the numbers. $80F - 64F = 16 \times 2.2 = 35.2\%$ rise in humidity; $70\% + 35.3\% = 105.3\%$ RH. We can't have over 100% humidity because the air can't hold more than 100% as it has reached its capacity. This air will then condense on the cold surfaces causing the air to give up its moisture as the relative humidity has reached its capacity to hold moisture. Condensation will form on the heating/cooling ducts, the water pipes, the block walls, the joists and the bottom of subfloor. The moisture in the subfloor will migrate up into the hardwood flooring causing it to cup, crack and sometimes buckle.



I have used a crawl space as the example but it is similar in basements if the conditions are created. Quite often people open basement windows to get rid of the stale air. With the same outside conditions as the above example (80 degrees F and 70% RH) with a basement temperature of 70F and RH of 40% here is what happens when not factoring in the higher outside humidity coming in: $80F-70F=10 \times 2.2=22.2\%$ rise in RH which will bring the new RH to 62% which is out of our recommended range. If you notice a smell in your basement or on things stored in your basement you most likely have a moisture problem. I suggest getting it under control by closing your basement windows and operating an appropriate size dehumidifier to remove this moisture; also there is a Humidex system that I am researching that seems quite simple and the company claims it will do a better job than a dehumidifier and would be less expensive to operate. Getting the humidity under control will lessen the odours.



In the above picture the mold was not visible until the drywall was removed from the wall. [In a new home the concrete will release moisture for 1.5 to 2 years.](#) This picture illustrates how the wood has absorbed the moisture from the concrete and drawn it up into the space. With this additional moisture and no air movement, the mold thrives.

The below chart shows how many gallons of water are needed to be added to a home in order to maintain the minimum 30% relative humidity at 75°F (24°C). Tight homes are new homes that are built with today's standards.

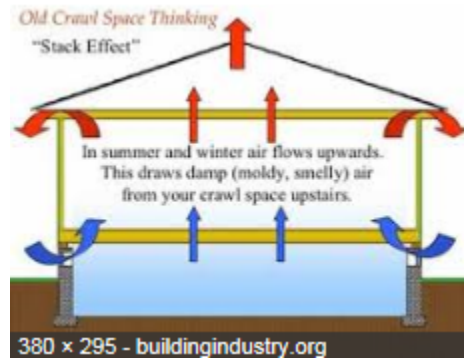
From AHRI Guideline F

Based on 75°F & 30% RH indoor and 0°F & 80% RH Outdoor conditions

Table 1 HUMIDIFICATION LOAD

Type of Construction	Gallons per Day					
	Size of House Square Feet (8 ft. Ceilings)					
	1,250	1,500	2,000	2,500	3,000	4,000
Tight	5.3	6.4	8.5	10.6	12.7	17.0
Average	10.6	12.8	17.0	21.3	25.4	34.0
Loose	15.9	19.1	25.5	31.8	38.1	51.0

You likely don't go down into your crawlspace unless you absolutely have to because of the damp musty smell. If you think that by shutting the door you have left that environment behind you are terribly wrong; due to the "Stack Effect" up to 50% of the air you breathe in your home comes from the crawl space.



The circulation in your home allows for up to 70% of the air you breathe to come from the basement. If your basement has a musty smell, this is not healthy to breathe as the health chart (discussed earlier) indicates. The musty smell is the result of the off gassing of the developing mold.

Window panes are usually the coldest surface inside the house during winter, so that is where condensation will appear first.

Outdoor Temperature at which Window Condensation Occurs

Glass Type	Outdoor Temp. (Fahrenheit)
Single glazing	50° or less
Double glazing	20° or less
Double glazing low-E	-10° or less
Double glazing low-E, argon	-30° or less

NOTE: Assumes 50% relative humidity indoors. Condensation may form along glass edge at higher temperature unless window has warm-edge spacers.



As the above chart indicates, the higher the quality of your windows, the less heat loss and condensation you will have.

Summary

1. Wood shrinks when exposed to low humidity and expands when exposed to high humidity. In the Northeastern Region we have very dry winters and humid summers, so it is important to control the humidity through humidification and dehumidification in order to keep yourself and your floors healthy.
2. Damp air takes more energy to heat and cool, so spending money to get rid of the dampness in a crawl space or basement will pay for itself not to mention the health benefits that can't be measured.
3. Engineered flooring handles high humidity better than solid hardwood but fails when exposed to dry conditions more than solid. Solid will shrink as a whole, while the top layer of solid wood on the engineered will shrink more than the plywood base causing the surface layer to crack.
4. Much of the air that you breathe is coming from your crawl space or basement. Odors and mold activity in the crawl space or basement are warning signs that your entire home may be making you sick.
5. The amount of moisture the air can hold increases as the temperature rises and decreases as the temperature cools. During the heating season with long stretches of cold temperatures, not adding humidity to your home will be harmful to your health as well as your floor. Please watch our Heat Recovery Ventilation video: <https://youtu.be/IXAmshK9OtM>
6. Window panes are usually the coldest surfaces in your home, which is where condensation will appear first. As the chart shows, lower quality windows with high heat loss are the first to show condensation. High quality windows will show condensation at much lower temperature due to less heat loss.