RELATIVE HUMIDITY & WOOD - NWFA

TECHNICAL TROUBLESHOOTING – BY BRETT MILLER, NATIONAL WOOD FLOOR ASSOCIATION

One of the easiest ways to avoid wood flooring installation failures is to have a clear understanding of relative humidity (RH) and its impact on wood. Wood is a hygroscopic material, which means that it will swell and shrink as it absorbs and loses moisture. This will happen as a direct result of the environment it is placed in. The environmental factors that affect wood flooring are the temperature and RH of the surrounding air.

Acclimation is the first step in managing how RH affects wood. Acclimation is the process that we use to bring wood to the moisture content that coincides with the expected in-use conditions of the facility in which it will be installed. This is known as bringing the wood to equilibrium moisture content (EMC).

As a general rule, wood floors will perform best when the interior environment is controlled to stay within a relative humidity range of 30 percent to 50 percent, and a temperature range of 60 degrees to 80 degrees Fahrenheit, but optimal conditions will vary in different regions based on average moisture content and RH.

For example, a dry area such as Nevada averages between 4 percent to 7 percent moisture content, while a humid or wet area like Florida averages between 12 percent to 13 percent moisture content. These regional variances along with the normal seasonal fluctuations directly affect the moisture levels at which wood flooring will find itself. Our job is to find out where the wood will reside and install the flooring at a moisture level that represents “normal.” When wood is neither gaining nor losing moisture, EMC has been reached.

MOISTURE CONTENT OF WOOD AT VARIOUS TEMPERATURES AND RELATIVE HUMIDITY READINGS

Temperature (°Fahrenheit)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	98
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

Relative Humidity (percent)

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

Heating and air conditioning units should be operating at least five days before delivery of the floors, during installation, and after the floors are installed. If this is not possible, a temporary system that mimics normal living conditions may enable installation to proceed.

Check the moisture content of both the wood flooring and the wood subflooring as soon as it is delivered to the jobsite to establish a baseline for acclimation. The moisture content of the wood subfloor will give you a good idea of what the anticipated living conditions in the environment will be. Acclimate (or condition) the flooring material for as long as necessary to reach optimal EMC for the jobsite, ensuring that the difference between the flooring and the wood subfloor is within 4 percent for strip flooring, or 2 percent for plank flooring. For concrete subfloors, be sure to use appropriate moisture control products to minimize any moisture migration from the subfloor to the wood itself.

Wood is considered acclimated only after it reaches EMC for the space in which it is expected to perform. EMC is based on an unchanging environment. After a wood floor has been installed, changing conditions within the environment will change the moisture content of the wood floor, ultimately resulting in dimensional change

Dimensional change with wood floors can occur in three different directions. Tangential dimensional change measures shrinking or swelling along the grain of annual growth rings. Average values of dimensional shrinkage from fiber saturation point to oven-dry are between 5 to 15 percent for most species of wood.

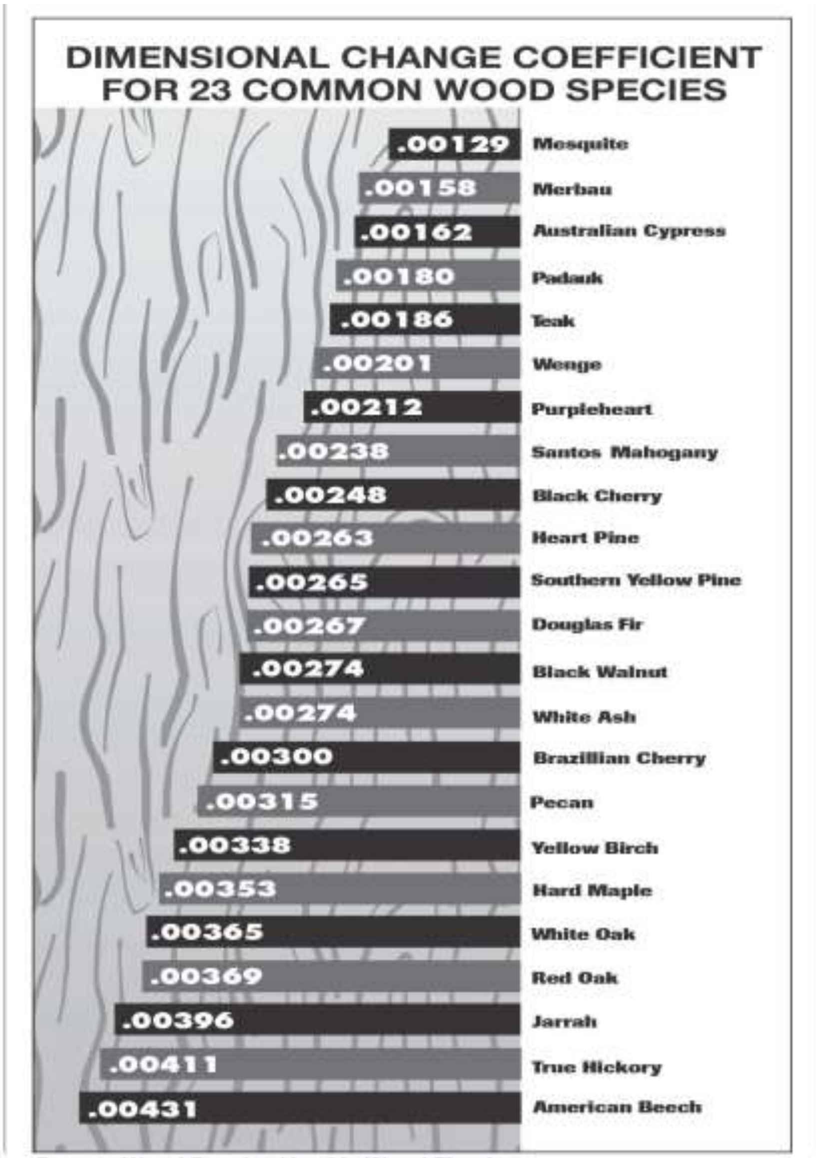
Radial dimensional change measures shrinking or swelling across the grain of annual growth rings. Average values of dimensional shrinkage from fiber saturation point to oven-dry are between 2 percent to 8 percent for most species of wood.

Longitudinal dimensional change generally is minuscule. Average values of shrinkage from green to oven-dry are between 0.1 to 0.2 percent for most species of wood.

Dimensional stability refers to how much a specific species of wood will shrink and swell based on gain or loss of moisture. A wood floor that is exposed to a relative humidity change of just 30 percent (moving from 30 percent RH to 60 percent RH), can experience enough dimensional change to affect the appearance and performance of the floor. How this change affects wood flooring depends on several factors. The most important are species (and valid dimensional change coefficient for the species) and cut (grain angle).

Wider boards tend to shrink and swell more than narrower boards because the actual dimension change is proportional to width. Movement of a 5-inch wide plank is more than twice as dramatic as that in a 2 1/4-inch strip of wood flooring.

To calculate how much a 5-inch piece of plainsawn red oak will be expected to shrink or swell when exposed to a room where the RH decreases or increases from 30 percent to 60 percent, conduct a simple calculation (Change in MC = 4.8 x 0.00369 x 5” = 0.08856” growth) using the EMC chart and the Dimensional Change Coefficient chart.



Source: Wood Species Used in Wood Flooring

Over 10 boards, that equates to 0.88-inch, which is more than 3/4-inch. Across a 10-foot wide room, that is more than 2 inches. This is enough movement to push walls from foundations or cause severe gapping between boards.

Keep in mind that wood flooring is constantly exposed to both long-term (seasonal) and short-term (daily) fluctuations in relative humidity and temperature of the surrounding air. This means that it is always undergoing slight changes in moisture content. These changes are usually gradual, and short-term fluctuations tend to only influence the surface of the floors. Moisture content changes can be slowed, but not entirely prevented, by protective coatings. Maintaining consistent temperature and humidity levels year-round by use of humidification/dehumidification systems will minimize and potentially alleviate noticeable changes altogether.

You can learn more about RH and how it impacts wood by participating in the NWFA University Wood Moisture Testing learning path. This learning path includes five courses that detail the relationship between wood and moisture. The courses include Acclimation & Conditioning, Moisture Content & Wood, Wood Moisture Testing, Wood Moisture Control, and Moisture-Related Wood Floor Issues. There also is a second learning path for Concrete Moisture Testing. These courses include Concrete Basics, Concrete Moisture Control, Concrete Moisture Testing, and Moisture & Concrete.

For more details, visit www.nwfa.org/nwfa-university.aspx.

Brett Miller is VP of Certification and Education at the National Wood Flooring Association in St. Louis. He can be reached at brett.miller@nwfa.org.