Equilibrium moisture content

The moisture content of wood below the fiber saturation point is a function of both relative humidity and temperature in the surrounding air. When wood is neither gaining nor losing moisture, an equilibrium moisture content (EMC) has been reached.

Wood technologists have graphs that precisely tie EMC and relative humidity together, but as a rule of thumb, a relative humidity of 25 percent gives an EMC of 5 percent, and a relative humidity of 75 percent gives an EMC of 14 percent.

A 50 percent swing in relative humidity produces an EMC change of 10 percent. How that affects wood flooring depends on which species is being used. However, let's say the width variation is just 1/16 inch for a 2¼-inch board. That's a full inch over 16 boards in a floor. Over the width of a 10-foot wide floor, that amounts to more than three inches of total expansion or contraction.

Protective coatings cannot prevent wood from gaining or losing moisture; they merely slow the process.

The seasoning of lumber

Freshly sawn lumber begins to lose moisture immediately. Its color will darken and small splits or checks may occur. Movement of moisture continues at a rate determined by many factors, including temperature, humidity and air flow, until a point of equilibrium is reached with the surrounding air. The shrinking and swelling of wood are dimensional changes caused by loss or gain of water.

In practical terms, the process works this way:

1.) A standing oak tree is felled and sawed into a board 1-inch thick, 10 inches wide and 8-feet long. Placed on a scale, the board weighs, say, 36 pounds.

2.) The board is placed in a stack of boards separated from the next by stacking strips of uniform size to keep the board straight. The stack is aimed at the prevailing breezes to accelerate drying. After two or three months of air drying, the board now weighs 25 pounds. It is also 31/32-inch thick, 9¾ inches wide and 8 feet long, with 25 percent moisture content.

3.) This 25-pound board is trucked to the flooring mill and loaded into a dry kiln, a building large enough to hold three or four railcar-loads of lumber. After six or seven days, this same board is now 15/16-inch thick, 9.2 inches wide, 8 feet long. It weighs 21.6 pounds with an 8 percent moisture content. If all the moisture were removed, the board would weigh 20 pounds.

The milling of lumber

Most hardwood lumber is dried to an average of 6 to 9 percent moisture content before milling is begun. Mill inspections conducted by the National Oak Flooring Manufacturers Association, allow 5 percent of the wood outside this range, to a maximum moisture content of 12 percent. The 6 to 9 percent range is likely to be the average of all types of wood products used in a normal household environment, assuming usual heating and cooling equipment is used to ensure human comfort.

WOOD FLOORING HAS A COMFORT LEVEL, TOO

Wood flooring will perform best when the interior environment is controlled to stay within a relative humidity range of 30 to 50 percent and a temperature range 60 to 80 degrees Fahrenheit. Fortunately, that's about the same comfort range most humans enjoy. The chart below indicates the moisture content wood will likely have at any given combination of temperature and humidity. Note that equilibrium moisture contents in the recommended temperature/humidity range (shaded area) coincide with the 6 to 9 percent range within which most hardwood flooring is manufactured. Although some movement can be expected even between 6 and 9 percent, wood can expand and shrink dramatically outside that range. *See page 6.*

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.