

APPENDIX B

ACCLIMATION

ALWAYS FOLLOW MANUFACTURERS' RECOMMENDATIONS REGARDING HOW AND WHETHER TO ACCLIMATE WOOD FLOORING.

Wood flooring is a hygroscopic material subject to dimensional change as a result of variations in moisture, temperature and humidity in the surrounding environment. That has led to increasing awareness of the need to properly acclimate wood flooring before installation. Wood flooring simply needs to reach a moisture content level in equilibrium with the surrounding environment in which it will be installed, at or near normal living conditions. Always account for time of year and geographic location.

NOTE: Not properly acclimating wood flooring may cause excessive expansion, shrinkage, dimensional distortion or structural damage

The point of acclimating wood flooring before installation is to allow the moisture content of the wood to adjust to the installation site's "normal living conditions" — that is, the temperature, humidity conditions and moisture content that will typically be experienced once the structure is occupied.

For site-finished wood flooring, after installation and before sanding and finishing, allow the flooring to acclimate to the controlled environment, and to stabilize for a period of time.

The worst-case scenario is one in which wood flooring is stored at the jobsite in an uncontrolled environment — especially one that is subject to excessive moisture and humidity conditions. It does no good at all — in fact it is likely harmful — to store wood flooring at the jobsite under conditions that don't reflect those normal environmental conditions. Garages, basements and exterior patios, for example, are not acceptable areas to store wood flooring.

Wood's Comfort Zone

As a general rule, with geographic exceptions, 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 of 60° to 80° Fahrenheit. (In some climates, the ideal humidity range might be higher or lower – 25 to 45 percent or 45 to 65 percent, for example.)

The chart on the following page 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 more dramatically outside that range. When wood is neither gaining nor losing moisture, equilibrium moisture content (EMC) has been reached.

Equilibrium Moisture Content of North American Wood Species at Various Temperatures and Relative Humidity Readings

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 of 60° to 80° Fahrenheit. Fortunately, that's about the same comfort range most humans enjoy. The charts below indicate the equilibrium moisture content of North American species of wood under various temperature and humidity conditions. **These values do not necessarily apply to imported species.** The left column indicates temperature in degrees Fahrenheit and Celsius. The bottom row indicates percent relative humidity. The values in the chart indicate the equilibrium moisture content (EMC) for any given combination of temperature and humidity. For example, at 70° Fahrenheit and 40% relative humidity, the equilibrium moisture content is 7.7%. **The shaded area indicates the generally recommended range for wood flooring — 6-9% EMC, which occurs when temperature is 60-80° Fahrenheit or 15-26° Celsius and 30-50% relative humidity.**

° F / C	EMC	EMC	EMC	EMC	EMC	EMC	EMC	EMC	EMC	EMC	EMC	EMC	EMC	EMC	EMC	EMC	EMC	EMC	EMC	EMC
30 / 1	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 / 4	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 / 10	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 / 15	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 / 21	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 / 26	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 / 32	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 / 37	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
% RH	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	98

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

Coefficients of Change: How Moisture Affects Wood Flooring

At 70° Fahrenheit, 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 variance 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. Installers need to take those expected dimensional variations into account when installing the wood flooring.

Proper Installation By Calculating Coefficients of Change

Proper installation depends not only on the moisture content of the wood and the environmental conditions at the time of installation, but also on expected seasonal changes in temperature and humidity at that location — changes that may cause the wood flooring to gain or lose moisture content over time. Such changes are likely to occur even if the building occupants maintain interior environmental conditions through use of a heating and/or air-conditioning system.

For example, if a wood flooring installation takes place when relative humidity is high, the wood flooring will lose moisture content and therefore shrink during low-humidity seasons. In that case, install the flooring tightly enough to minimize the expected separations that will occur as the boards shrink during dry seasons. Conversely, if an installation takes place when humidity conditions are low, it's likely that the wood flooring will gain moisture and expand during humid seasons. In those cases, incorporate additional expansion space through use of spacers.

How much expansion space to leave will depend on the expected changes in moisture content of the wood flooring, and that will depend on the dimensional change coefficient of the species being installed and the width of the flooring.

Predicting temperature and humidity changes: Installers may have a climate history for the areas in which they typically install wood flooring, or climate data is also available from a variety of sources, including the National Weather Service (www.weather.gov) and Weather Underground (www.wunderground.com).

Calculating dimensional change: Different species of wood flooring exhibit different coefficients of change and, therefore, have different rates of dimensional stability. That is, some woods are more prone to expansion and shrinkage than others. The National Wood Flooring Association's *Technical Publication No. A200: Wood Species Used in Wood Flooring* lists dimensional change coefficients for many common wood species used in wood flooring.

To calculate the expected dimensional change in wood flooring, you will need to determine the current moisture content of the wood flooring, using a moisture meter. Then calculate the expected change in moisture content, using the equilibrium moisture content chart above and the climate data for the location in which then flooring is to be installed. Finally, you will need to know the dimensional change coefficient of the species to be installed.

With that information in hand, you will be able to perform a simple calculation that will tell how much the wood flooring is likely to expand or shrink. That calculation multiplies the change in moisture content by the change coefficient, multiplied by the width of the flooring boards.

Change coefficient x moisture content change x board width = dimensional change

For example, let's say that climate data for the location indicates that the maximum moisture content for the wood flooring will be 9.1 percent (relative humidity of 50 percent and temperature of 80°). Let's also say that the wood flooring currently has a moisture content reading of 6.1 percent. That means the wood is likely to experience a change in moisture content of 3 percent (9.1% - 6.1%) from dry season to humid season. In the example, let's say that the wood flooring to be installed is 5-inch plank red oak. Red oak has a change coefficient of .00369. We now have the data we need:

Change coefficient = .00369
Moisture content change = 3%
Board width = 5 inches

The following calculation would apply: $.00369 \times 3 \times 5 = .055 \text{ inches}$

In other words, for every 3-percentage-point increase in moisture content, a 5-inch board will expand by more than 1/20th of an inch. Over 10 boards, that will equal over ½ inch of expansion — something the installer will need to take into account, although in actual practice the installation and fastening process will tend to restrain board movement somewhat.

The Process of Acclimation

If the manufacturer recommends that the wood flooring be acclimated before installation, proceed as follows:

- First, ensure that the building is enclosed.
- Second, ensure that the building is maintained at normal living conditions for temperature and humidity. It does no good to acclimate flooring to interior conditions that are too moist or too dry, or in any way significantly outside the range of conditions likely to be found in the building after the flooring is installed. In fact, it is counterproductive.
- Where building codes allow, permanent heating and/or air-conditioning systems should be operating at least five days preceding installation to promote proper acclimation. Where building codes do not allow for operation of the permanent system, acclimation of the flooring must be completed with the temperature and humidity maintained at or near normal living conditions, which generally fall between 60° to 80° Fahrenheit and at the average yearly relative humidity for the area.
- If it is not possible for the permanent heating and/or air-conditioning system to be operating before, during and after installation, a temporary heating and dehumidification system using electric heating units, dehumidifiers and industrial fans can enable the installation to proceed until the permanent heating and/or air-conditioning system is operating.
- Upon delivery, check wood flooring moisture content with a moisture meter to establish a baseline for required acclimation. Acclimate to manufacturer's recommendations or as necessary according to geographical location. **See Appendix D, Moisture by Area – U.S., and Appendix E, Moisture by Area – Canada.**
- Acclimation can be facilitated by breaking the floor units into small lots and/or opening the packaging. A common practice is to stack the flooring, with ¾-inch to 1-inch sticks between each layer of flooring to allow air circulation on all sides of all boards.

Note: Some manufacturers do not require acclimation for certain products prior to installation.

- For solid strip flooring (less than 3 inches wide), when an industry-approved vapor retarder with a proper perm rating is installed between the flooring and the subfloor, there should be no more than 4 percent moisture content difference between properly acclimated wood flooring and subflooring materials. For wide-width (3" or wider) solid flooring, there should be a moisture content difference of no more than 2 percent between properly acclimated wood flooring and subflooring materials. For wide-width flooring, many industry professionals also suggest using an adhesive as an assist to mechanical fastening. However, the adhesive may not provide sufficient moisture protection to substitute for an industry-approved vapor retarder. Also, when an adhesive is applied over a vapor retarder, care should be taken to ensure that the adhesive and vapor retarder are compatible with one another. In most cases, adhesives are not compatible with asphaltic or paper-type vapor retarders.