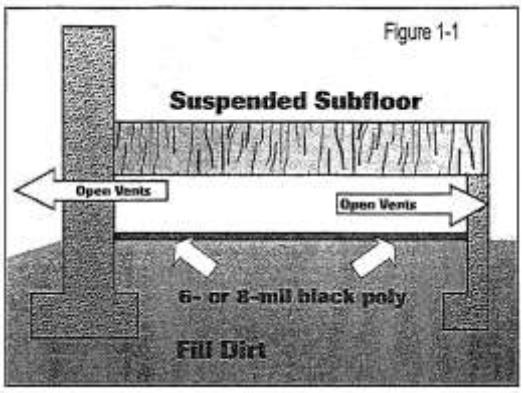
Section I
General Guidelines

Chapter 1
Jobsite Conditions

Wood flooring by design is not to be used to strengthen/stiffen a subfloor and will not do so. If movement of the subfloor occurs prior to installation and is not corrected, that same movement will occur after installation is complete.

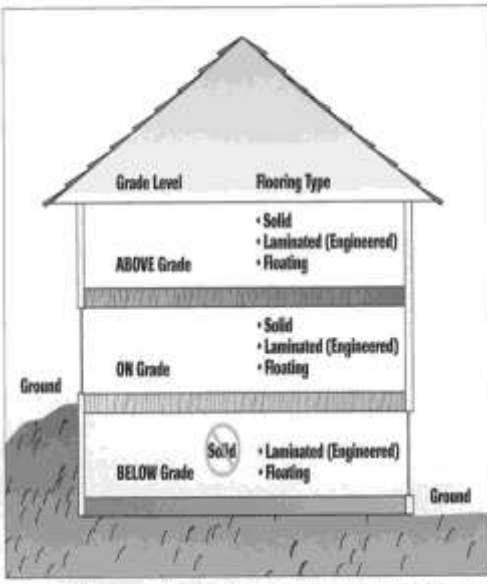
Part I
Minimum Jobsite Requirements

A. Wood flooring should be one of the last jobs completed on the construction project. Limit foot traffic on finished wood flooring.
B. Evaluate the jobsite for potential problems before installation begins, and before wood flooring is delivered to the jobsite.
C. Installation constitutes acceptance of flooring material, subfloor/substrate, the jobsite itself including the ambient temperature and relative humidity at the time of installation, and all impacting variables that may affect a wood floor. For warranty and/or hold harmless agreements, check with legal counsel.
    1. Exterior surface drainage should direct water away from the building.
    2. Do not deliver wood flooring to the jobsite or install wood flooring until the building is enclosed.
    3. If heating and/or air conditioning is in operating condition, it needs to be operating. 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/or dehumidification system that mimics normal temperature and humidity conditions can enable the installation to proceed until the permanent heating and/or air conditioning system is operating.
    4. Do not deliver wood flooring to the jobsite or install wood flooring until appropriate temperature and humidity conditions have been achieved. Appropriate temperature and humidity conditions are defined as those conditions to be experienced in the building after occupancy.
    5. Do not deliver wood flooring to the jobsite or install wood flooring until all concrete, masonry, plastering, drywall, texturing and painting primer coats are completed.
    6. Basements and crawl spaces must be dry. If power washing is required in the basement, do so before wood flooring is installed and allow subfloor and basement to dry before installing wood flooring.
    7. Crawl space should be a minimum of 18” (457mm) from ground to underside of joists.
    8. Crawl space earth (or thin concrete slab) should be covered 100 percent by a vapor retarder of black polyethylene (minimum 6 mil) or any recommended puncture-resistant membrane, such as Class C, meeting ASTM D1745. See Figure 1-1. Check local codes.
    9. Crawl Space Conditions
        a. Where a proper ground covering is in place and when venting is required by local building codes, the crawl space should have perimeter venting equal to a minimum of 1.5 square feet per 100 square feet of crawl space square footage, unless local building codes differ from this specification. Note: Local building codes may differ. Follow local building codes.
        b. For crawl spaces without ventilation openings, vapor retarder joints must overlap a minimum of 6 inches and be sealed or taped. The vapor retarder should also extend at least 6 inches up the stem wall and be attached and sealed to the stem wall. Continuously operated mechanical exhaust and perimeter wall insulation or conditioned air supply and insulation must be provided.



10. Note the grade level so that the correct type of flooring and system can be specified for the job. Engineered and floating floors can be appropriate for above-grade, on-grade and below-grade installations. Solid wood flooring can be appropriate for above-grade and on grade installations, but not for below grade installations. If the soil surrounding a structure is 3 inches or more above the floor of any level, consider that level below grade. This includes walk-out basements. In addition, the surrounding soil should be sloped away from the structure. See Figure 1-2.
11. Subfloors (wood or concrete) should be checked by an appropriate method for establishing moisture content. Average subfloor moisture content should be within the range as specified for the product by the product manufacturer. See Chapter 3, Moisture Testing. See Figure 1-2.
12. Where the minimum jobsite conditions are present, the flooring can be delivered and stored in the rooms in which it will be installed. See Chapter 2, Acclimation and Conditioning of Wood Flooring.

Figure 1-2



If any part of the soil surrounding a structure is above the floor of any level, consider that level below-grade. This includes walk-out basements. In addition, the surrounding soil should be sloped away from the structure with at least 6 inches of fall over the first 10 feet.

Part II
Additional Jobsite Conditions for Factory-Finished Flooring

A. All finished wall coverings and painting should be completed. Note: Base and shoe mold may be installed after the flooring installation.
B. After installation, if you choose to protectively cover the floor, cover the floor completely, since some species are light-sensitive and uncovered areas may change color. However, covering a glue-down application may not allow some adhesives to properly cure. Follow the flooring and adhesive manufacturer's recommendations. Use a covering material with a vapor permeance (perm rating) of 1 perm or more (tested in accordance with ASTM E96) to avoid trapping moisture/vapor on or within the floor. Any covering should be taped, using a low-adhesion tape, to base or shoe moldings. Do not tape to finished flooring. When taping paper or sheets together, tape them to each other, not to the floor.

   As in all installations, at completion of job, inspect flooring from a standing position.

Part III
Jobsite Checklist
See Appendix M.

Part IV
Remodel Installations
Be aware of the most current EPA regulations for lead paint dust as well as asbestos (www.epa.gov).

Chapter 2
Acclimation and Conditioning of Wood Flooring

Always follow the manufacturer's recommendations regarding how and whether to acclimate wood flooring.

Part I
General Acclimation/Conditioning Guidelines

Definitions:
Acclimation: The process of adjusting (conditioning) the moisture content of wood flooring to the environment in which it is expected to perform.

Equilibrium Moisture Content: The moisture content of wood when in equilibrium with its environment. When wood is neither gaining nor losing moisture, equilibrium moisture content (EMC) has been reached.

A. Storage and Conditions
    1. Do not store wood flooring at the jobsite under uncontrolled environmental conditions. Garages, and exterior patios, for example, are not acceptable areas to store wood flooring.
    2. Ideal interior environmental conditions vary from region to region and jobsite to jobsite. It is the flooring professional's responsibility to know what the "ideal" climate conditions are and customize the floor around those conditions.
        a. Determine what the expected seasonal change of wood moisture content is for your geographical location. For a general view of moisture-content averages by region, See Appendix D and Appendix E.
        b. Upon delivery, check wood flooring moisture content with a moisture meter to establish a baseline for acclimation. Check the moisture content of multiple boards. A good representative sample is typically 40 boards for every 1,000 square feet of flooring. Calculate what the optimal wood moisture content is (baseline) by dividing the high season and low season. Example: If your region has an expected EMC from a low of 6% to a high of 9%, the baseline MC of the wood would be 7.5%. If wood flooring is delivered and recorded to its baseline MC for the geographical location and proper relative humidity conditions are maintained, no acclimation may be required**.** If the moisture content of the product received is well outside of the range of optimal moisture content, it will be very difficult to acclimate the product properly without substantial dimensional change, distortion, and structural damage. Example: If the moisture content of the delivered wood is 12% and the optimal range is 6%, excessive shrinkage, bowing, cupping and other physical anomalies would be expected during the acclimation process. The wood flooring should not be accepted.
        c. Optimal wood moisture content represents only a base line to begin from and does not represent the final EMC required for the interior environment. Acclimation is often required to customize the moisture content of the wood flooring to the interior environment in which it is expected to perform.

B. General
    Note: Some manufacturers do not require acclimation for certain products prior to installation. If the manufacturer recommends that the wood flooring be acclimated before installation, proceed as follows:
    1. Ensure that the building is enclosed.
    2. Verify that the building is maintained at normal living conditions for temperature and humidity.
    3. Where building codes allow, permanent heating and/or air conditioning systems should be operating at least five days preceding installation to promote proper acclimation and should be maintained during and after installation. For radiant heat, see Appendix H.
    4. 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/or dehumidification system that mimics normal living (occupied) conditions can enable the installation to proceed until the permanent heating and/or air conditioning system is fully operational.
    5. Acclimate the wood flooring as necessary (see Chapter 2, Part II, Acclimation).

Note: Not properly acclimating wood flooring may cause excessive expansion, shrinkage, dimensional distortion or structural damage. The worst-case scenario is one in which wood flooring is stored at the jobsite in an uncontrolled environment, then immediately installed. This is especially true when the materials are stored in an area that is subject to excessive moisture and humidity conditions. Acclimation outside of the area in which the wood is to be installed does no good at all; in fact, it is likely harmful to store wood flooring at the jobsite under conditions that don't reflect expected normal environmental conditions.

6. Prior to installation, ensure that wood flooring is within acceptable range of moisture content with the wood subfloor. For solid strip flooring (less than 3" wide), there should be no more than 4 percent moisture content difference between properly acclimated wood flooring and subflooring materials. For wide-width solid flooring (3" or wider), there should be no more than 2 percent difference in moisture content between properly acclimated wood flooring and subflooring materials.

Part II
Acclimation

Wood flooring is a hygroscopic material subject to dimensional change as a result of variations in moisture, temperature and humidity within the surrounding environment. Wood flooring simply needs to reach moisture content level in equilibrium with the surrounding environment (EMC) in which it will be installed, at or near normal living conditions. The process of reaching this equilibrium is defined as acclimation, which allows the wood to properly adjust itself to the normal living conditions within the structure; that is, the temperature, humidity conditions and moisture content that will typically be experienced once the structure is occupied.

A. The Process of Acclimation

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

1. Acclimation can be facilitated by breaking the floor units into small lots and/or opening the packaging. A common practice is to cross-stack the materials with spacers (¾" to 1" sticks) between each layer of flooring to allow air circulation on all sides of all boards.
2. Most recommendations state that the materials need to acclimate from a minimum of 3 days up to no given maximum. While it takes time to acclimate a product, the most important aspect is that the materials reach a moisture content that is in equilibrium with its expected use. Acclimate the materials as long as necessary to accomplish this task, taking the necessary moisture readings to indicate when the materials have reached the proper moisture content and when no further changes occur.
    a. For site-finished wood flooring, after installation and before sanding and finishing takes place, allow the flooring to acclimate (settle-in) to the controlled environment, and to stabilize for a period of time. Some flooring professionals suggest 5 to 7 days. Engineered flooring installed using an adhesive application system may require a longer post-installation acclimation period to allow all residual off-gassing to occur prior to application of a finish. Follow adhesive manufacturer's recommendations.
    b. Tropical imported species generally require more time in order to properly acclimate the wood flooring. Some tropical species lose moisture or gain moisture at faster or slower rates than domestic species due to higher overall density, oil and resin content and interlocking cell structure. In addition, the resins and oils make accurate MC readings more difficult. Resistance (pin type) meters require multiple readings of multiple boards in order to arrive at a more accurate average MC reading. Pinless meters that include multiple depth level adjustments may offer faster and more-accurate internal readings.
    c. Engineered and solid factory finished flooring follows specific manufacturer's recommendations and some may not require acclimation. Follow manufacturer's guidelines to retain all warranty coverage. Warranty coverage generally requires that jobsite conditions be maintained between 30% to 50% relative humidity and that those conditions must be maintained before, during and after installation for the life of the floor. Failure to comply with these manufacturer's requirements may result in irreversible structural damage and void related warranties.

B. Wood's Comfort Zone

1. 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.)
2. The chart below indicates the moisture content wood will likely have at any given combination of temperature and humidity. Note the equilibrium moisture content in the recommended temperature/humidity range (shaded area) coincides with the 6-to-9 percent range used by most flooring manufacturers during the manufacturing/shipping process. Although some movement can be expected between 6 and 9 percent, wood flooring can shrink or swell more dramatically outside this range. When wood is neither gaining nor losing moisture, equilibrium moisture content (EMC) has been reached.

Equilibrium Moisture Content of Solid 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% and a temperature range of 60° to 80° Fahrenheit. Fortunately, that's about the same comfort range most humans enjoy. The chart below indicates the equilibrium moisture content of wood flooring at various temperatures and humidity conditions. 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

See Chapter 9, Solid Strip and Plank Flooring Installation.

Chapter 3
Moisture Guideline Testing and Vapor Retarders

Reference to ASTM Standard revisions: ASTM Standards listed are most recent revisions or use ASTM Standard in effect at time of installation.

Part I
Moisture Testing for Wood Flooring and Wood Subfloors
Determining moisture content is an essential part of quality control within the flooring installation process. Flooring Installers must know the moisture content of the wood flooring, as well as the subfloor.

A. The most accurate measurement for moisture content in wood is the oven-bake-out method. However, it is not widely used because the cost and difficulty of performing the test on-site is not practical.
B. Hand-held electrical tools, called moisture meters, should be part of the toolbox of every flooring contractor for measuring moisture in subfloors and floors. Moisture meters have many purposes. They can be used to determine if floor boards are dry enough for an installation to proceed, they can check subfloors and concrete for high moisture levels, they can determine when a second coat of finish can be applied and they can assess water damage.

   There are two main types of meters for testing wood: probe and pinless.
   1. The probe type measures electrical resistance across opposed sets of pins, which are pushed into the wood. All probes should be inserted parallel with the grain or as instructed by the meter manufacturer. An advantage of probe type meters is that those with insulated pins are able to measure moisture content at varying depths; for example, you can determine whether the moisture content near the bottom of the board is higher than near the top.
   2. The pinless, dielectric type employs signal penetration at one inch or more for both hardwood and softwood. The meter can be moved across the surface to identify pockets of moisture. It is relatively unaffected by temperature. Rough surfaces have very little effect on the reading. Measurements can also be taken through coatings, varnish or paint without damage to the surface. Newer pinless meters can be adjusted to depth desired. Older models may read deeper into flooring systems and not give an accurate reading of wood flooring only.
   3. Follow the meter manufacturer's recommendations to get an accurate reading from the wood floor. One effective testing method is to remove a sample board and get a reading with air space beneath it.
   4. It is important that the meter you chose offers the following:
      a. A wide moisture content range from at least 6 percent to 30 percent.
      b. The necessary adjustment tables, conversion charts or settings for various species.

   Test for moisture at several locations in the room – a minimum of 20 per 1,000 square feet – and average the results. Document all results. A high reading in one area indicates a problem that must be corrected. Pay special attention to exterior and plumbing walls.

Part II
Moisture Testing for Concrete Slabs
Note: All tests give a result – at the time the test is done – and in general give you the ability to start or not start a job. These tests do not give a permanent condition of your substrate, but merely a "at the time the test was performed" indication.

A. Testing Requirements
   Before moisture testing begins, the concrete slab must be a minimum of 30 days old.
B. Qualitative Moisture Tests – Electrical Impedance Test and Electrical Resistance Test (Moisture Meter)
   Follow meter manufacturer's instructions.
   1. Use moisture meters designed specifically for concrete moisture testing.
   2. Test within the body of the slab (electrical resistance), as well as at the surface (electrical impedance).

3. These testing methods are not recognized by any standard and should not be used for the purpose of accepting or rejecting a floor. These electronic tests are useful survey tools to broadly evaluate the relative moisture conditions of a slab and to select locations for quantitative moisture tests.
4. If the moisture meters indicate the presence of excessive moisture, as per wood flooring or meter manufacturer's recommendations, further testing is required using relative-humidity testing (ASTM F2170), calcium chloride testing (ASTM F1869) or calcium carbide (CM) testing (ASTM D4944 and MilSpec CRD-C154-77).

C. Quantitative Moisture Tests
1. ASTM F1869 – Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor using Anhydrous Calcium Chloride.
    a. This test method covers the quantitative determination of the rate of moisture vapor emitted from below-grade, on-grade, and above-grade (suspended) bare concrete floors.
2. ASTM F2170 – Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs using in Situ Probes.
    a. This test method covers the quantitative determination of percent relative humidity in concrete slabs for field or laboratory tests.
3. ASTM F2659 – Standard Guide for Preliminary Evaluation of Comparative Moisture Condition of Concrete, Gypsum Cement and Other Floor Slabs and Screeds Using a Non-Destructive Electronic Moisture Meter.
    a. This guide focuses on obtaining the comparative moisture condition within the upper 1" (25.4 mm) stratum in concrete, gypsum, anhydrite floor slabs and screeds for field tests. Due to the wide variation of material mixtures and additives used in floor slabs and screeds, this methodology may not be appropriate for all applications. See 1.2 through 1.8 and Section 11 of ASTM F2659. Where appropriate, or when specified, use further testing as outlined in Test Methods F1869, F2170 or F2420 before installing a resilient floor covering.
4. ASTM F2420 – Standard Test Method for Determining Relative Humidity on the Surface of Concrete Floor Slabs Using Relative Humidity Probe Measurement and Insulated Hood.
    a. This test method covers the quantitative determination of percent relative humidity above the surface of concrete floor slabs for field or laboratory tests.
5. Relative Humidity Testing – ASTM F2170 (Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using In Situ Probes).
    a. Select test locations to provide information about moisture distribution across the entire concrete floor slab. For slabs on grade and below grade, include a test location within three feet of each exterior wall.
    b. Perform three tests for the first 1,000 square feet and one test for every additional 1,000 square feet thereafter.
    c. At least 48 hours before test is placed, concrete floor slabs should be at the same temperature and humidity that is expected during service conditions.
    d. Use a rotary hammer-drill to drill holes in the concrete slab; 40% depth of slab is required for the holes when concrete is drying from one side and 20% when drying from both sides. Follow manufacturer's instructions provided with test kits.
    e. Allow 72 hours to achieve moisture equilibrium within the hole before making relative humidity measurements. Follow manufacturer's instructions provided with test kits.
    f. ASTM F710 provides installation guidelines for acceptance of hardwood flooring using relative humidity testing. Typical limits for wood and wood-based products are 75% relative humidity. When getting readings over 75%, you must use a proper vapor retarder, based on the flooring manufacturer's recommendations, or wait for further concrete curing.
6. Calcium Chloride Test – ASTM F1869 (Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride).
    a. Select test locations to provide information about moisture distribution across the entire concrete floor slab.
    b. Perform three tests per 1,000 square feet of surface area. Add one additional test for each 1,000 square feet thereafter.

c. At least 48 hours before test is placed, concrete floor slabs should be at the same temperature and humidity expected during service conditions.
d. The actual test area shall be clean and free of all foreign substances. Use approved OSHA work practices for removal of all existing flooring materials and debris.
e. Blast or grind a minimum area of 20 inches by 20 inches and let stand for a minimum period of 24 hours prior to setting test.
f. Follow manufacturer's instructions for properly placing tests onto concrete.
g. Tests are to be covered and left in place for 60 to 72 hours. Follow manufacturer's instructions for labeling and recording time and date of test.
h. Send the test to a certified laboratory for results and documentation, or perform the measurements as per ASTM F1869.
i. Always follow the flooring manufacturer's guidelines and specifications to determine when the concrete slab is ready for installation.
j. ASTM F710 provides installation guidelines for acceptance of hardwood flooring using alciumchloride testing. Typical limit for direct glue-down wood flooring is 3lbs/1000sf/24hr. When getting readings over 3lbs and up to 7lbs, you must use a vapor retarder. A reading over 7lbs may not be acceptable for wood flooring installation. Follow the wood flooring manufacturer's recommendations. In the case of a glue-down installation, the adhesive manufacturer may also have recommendations.
Note: For information on the tests listed above, contact your distributor or call NWFA at 800.422.4556 (USA or Canada) or 636.519.9663 for the source nearest you.

7. Calcium Carbide (CM) Test – ASTM (modified) D4944, MilSpec CRD-C154-77.
a. The calcium carbide test, also known as the CM test or calcium carbide bomb, is more widely used in Europe than in the United States. It is a gas-pressure test in which moisture in the concrete reacts with calcium carbide crystals to create acetylene gas, and the gas pressure produced is measured to provide a moisture content reading, expressed as a percentage of moisture. Follow the directions provided by the test-kit manufacturer. A reading of more than 2.5% requires use of a vapor retarder. A reading of more than 4% may not be acceptable for wood flooring installation. Follow the wood flooring manufacturer's recommendations. In the case of a glue-down installation, the adhesive manufacturer may also have recommendations.

Part III
Acceptable Vapor Retarders Over Wood Subfloors

A. Always follow local codes and manufacturer's instructions for acceptable vapor retarders.
Note: The 2012 IBC defines three classes of vapor retarders:
1. Class I 0.1 perm or less.
2. Class II 0.1 perm less than or equal to 1.0 perm.
3. Class III 1.0 perm less than or equal to 10 perm.
When tested in accordance with ASTM E96 Method A.

B. An acceptable vapor retarder is a vapor resistant material, membrane or covering with a vapor permeance (perm rating) of greater than or equal to .7 and less than or equal to 10 when tested in accordance with ASTM E96 Method A. Installation of a vapor retarder reduces the potential for moisture or vapor related problems, but does not guarantee elimination of moisture or vapor related problems. Install a vapor retarder over wood panel or board subfloors prior to installing nail down solid strip or plank flooring. Overlap seams a minimum of 4 inches or more as required by manufacturer or specifier and local building codes.

C. Some examples of acceptable vapor retarders over wood subfloors include:
1. An asphalt laminated paper meeting UU-B-790a, Grade B, Type I, Style 1a.
2. Asphalt-saturated kraft paper or #15 or #30 felt paper meeting ASTM Standard D4869 or UU-B-790.

D. Note:
1. A vapor retarder has some extra benefits in that it eliminates wood-on-wood contact, wood strips slide more easily when positioned, it minimizes the impact of seasonal humidity change and it may reduce dust and noise levels.

2. However, by today's standards, asphalt saturated kraft or felt paper may not be an effective vapor retarder, with a Class III perm rating of 1.0 perm <10, in all applications. Consult local codes.
3. Over a wood subfloor, do not use an impermeable vapor retarder material with a perm rating of .7 or less, such as 6 mil polyethylene film or other polymer materials, as it may trap moisture on or in the wood subfloor. Such impermeable material may be used if recommended by the wood flooring manufacturer as such materials have been measured for vapor transmission due to fastener penetration or include special backing to dissipate vapor horizontally.

Job Site Platform	Grade Level	Subfloor Material	Flooring Type	Floor Installation Method	Adhesive Product Type	Adhesive Application	NWFA Guideline	Acceptable Vapor Retarder	NWFA Membrane Standard	ASTM E96 Required Perm Rating	Note: Always follow manufacturer, specifier and/or local code requirements. Installation of a vapor retarder reduces the potential for, but does not guarantee elimination of, moisture or vapor related problems.
Crawl space vented	On or below	Wood panel or board on joist above earth or slab	Solid or engineered	Floating, mechanically attached or adhered	N/A	N/A	1.C.5-8 jobsite min. req. 1.1.C.8 vapor retarder 1.1.C.9a crawl vented	Membrane min. 6 mil: i.e., poly C&A film or superior high strength membrane	ASTM E96 ASTM D4397 ASTM E1745	Min. ≤ 0.15 Best ≤ 0.02	ASTM E96-10/E96M-10 Standard Test Methods for Water Vapor Transmission of Materials ASTM D4397-10 Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications (C&A Film) ASTM E1745-09 Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
Crawl space not vented	On or below	Wood panel or board on joist above earth or slab	Solid or engineered	Floating, mechanically attached or adhered	N/A	N/A	1.C.5-8 jobsite min. req. 1.1.C.8 vapor retarder 1.1.C.9b crawl not vented	Membrane min. 6 mil: i.e., poly C&A film or superior high strength membrane	ASTM E96 ASTM D4397 ASTM E1746	Min. ≤ 0.15 Best ≤ 0.02	ASTM E96-10/E96M-10 Standard Test Methods for Water Vapor Transmission of Materials ASTM D4397-10 Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications (C&A Film) ASTM E1745-09 Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
Crawl space conditioned	On or below	Wood panel or board on joist above earth or slab	Solid or engineered	Floating, mechanically attached or adhered	N/A	N/A	Follow codes and system manufacturer directions	Follow codes	Follow codes	Follow codes	A conditioned crawl space or basement, though not the responsibility of the floor installer, is very desirable when temperature and humidity are properly maintained within the crawl space.
Wood	Above or on	Wood panel or board on joist	Solid or engineered	Nail/staple down	N/A	N/A	3.II.A-B 9.VI.D	Membrane: i.e., saturated or laminated - felt or paper	ASTM E96	0.7 ≤ 10.0	Overlap seam 4" min. or more
Wood	Above or on	Wood panel or board on joist	Engineered	Floating	N/A	N/A	3.II.A-B 8.VI.F	Roll or sheet membrane: i.e., min. 6 mil poly C&A film or superior ASTM D1745 membrane. Foam pad, vented or other membrane	ASTM E96	0.7 ≤ 10.1	Overlap seam 4" min. or more
Wood (FDN)	Below	Wood panel on joist	Engineered	Nail/staple down or floating	N/A	N/A	3.II.A-B 8.VI.F	Membrane: i.e., saturated or laminated - felt or paper	ASTM E96	0.7 ≤ 10.0	Overlap seam 4" min. or more

Part IV
Acceptable Vapor Retarders Over Concrete

A. Always follow local codes and manufacturer's instructions for acceptable vapor retarders.
B. Test concrete for moisture. For concrete slabs with a calcium chloride reading of greater than 3lbs, a relative humidity reading of greater than 75%, or a calcium carbide (CM) rating of greater than 2.5%, install an impermeable vapor retarder with a perm rating of less than .15 perm. Adding a vapor retarder is not required on installations over slabs with a calcium chloride reading of 3lbs or less, a humidity reading of 75% or less, or a calcium carbide (CM) rating of 2.5% or less. However, in on-grade and below-grade applications, adding a vapor retarder is always recommended.
C. The 2012 IBC defines three classes of vapor retarders:
    1. Class I 0.1 perm or less.
    2. Class II 0.1 perm less than or equal to 1.0 perm.
    3. Class III 1.0 perm less than or equal to 10 perm.

    When tested in accordance with ASTM E96 Method A.
D. The NWFA recommends an "impermeable" vapor retarder with a perm rating of less than or equal to .15, thereby limiting the passage of moisture to near zero.
E. Some acceptable vapor retarders over concrete include:
    1. A minimum 6 mil construction grade polyethylene film or other impermeable material with a perm of .15 or less is recommended. A premium polymer material meeting ASTM E1745 for concrete with higher tensile, tear and puncture resistance is highly desirable.
    2. Double felt: Two layers of #15 asphalt saturated felt paper that meets ASTM Standard D4869, with the first layer adhered to the slap in a skim coat of appropriate asphalt mastic type adhesive recommended by manufacturer, and a second layer felt adhered to the first layer with same appropriate adhesive.
    3. A chemical retarder or urethane membrane, as recommended by the adhesive or wood flooring manufacturer. These are usually in the form of a liquid-applied or trowel-applied membrane dispensed from a bucket following manufacturer recommendations.
    4. Installation membrane: a permanently elastic, cross linked, closed cell polyethylene membrane. Follow membrane manufacturer instructions.
    5. A loose laid or mechanically fastened plastic, waterproof, dimple type membrane, providing a thermal air gap separating finished floor from concrete. Follow membrane and floor manufacturer installation instructions.
    6. An elastomeric, fully adhered or mechanically fastened membrane with seams sealed. Follow membrane manufacturer installation recommendations.

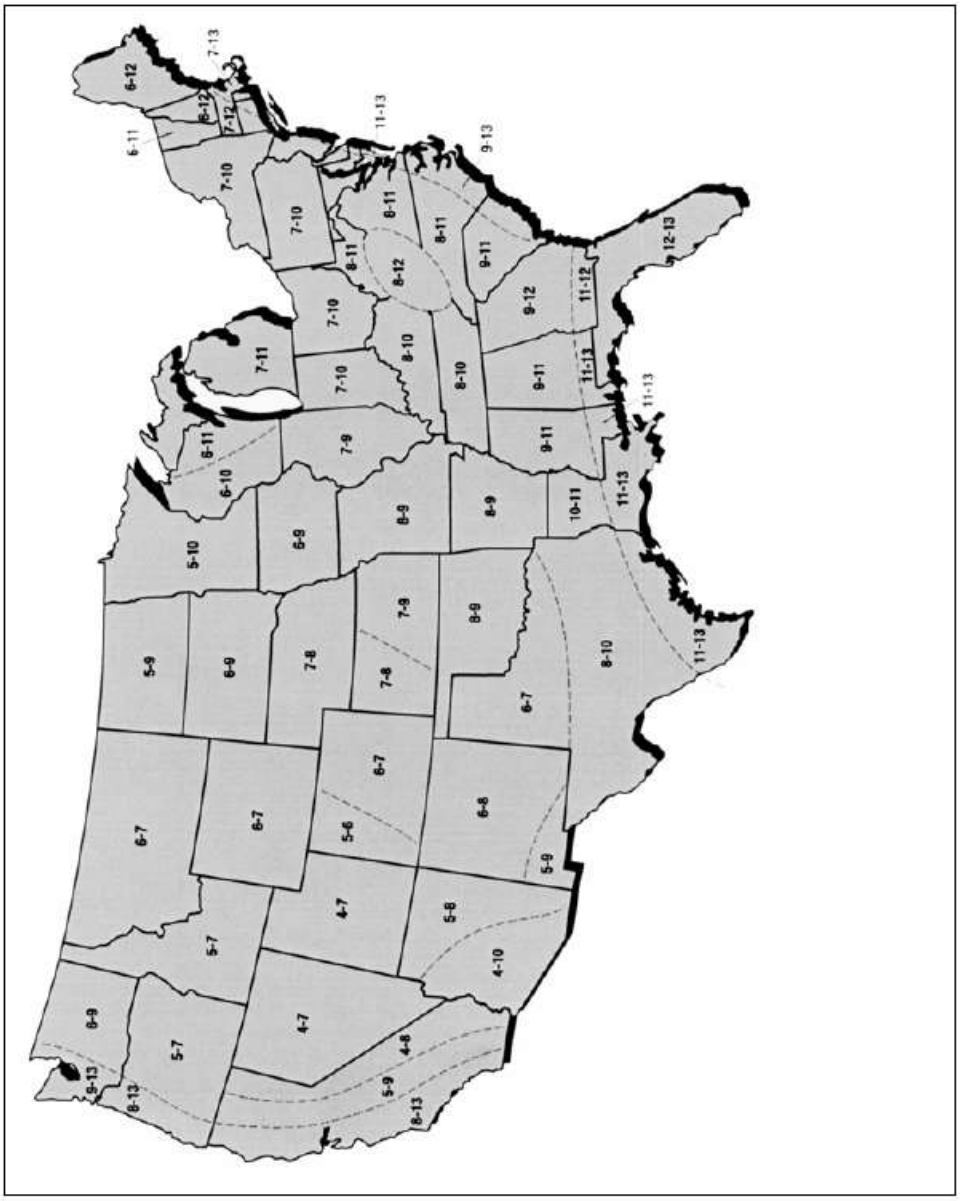
Job Site Platform	Grade Level	Subfloor Material	Flooring Type	Floor Installation Method	Adhesive Product Type	Adhesive Application	NWFA Guideline	Acceptable Vapor Retarder	NWFA Membrane Standard	ASTM E96 Required Perm Rating	Note: Always follow manufacturer, specifier and/or local code requirements. Installation of a vapor retarder reduces the potential for, but does not guarantee elimination of, moisture or vapor related problems.
Concrete	Above or on	Concrete	Solid or engineered	Floating	N/A	N/A	6.II.A-E nail down floating plywood methods	Roll or sheet membrane: i.e., min. 6 mil poly C&A film or superior ASTM D1745 membrane. Foam pad, vented or other membrane.	ASTM E96	Min. ≤ 0.15 Best ≤ 0.02	Vapor retarder seams must be sealed with an impermeable material with a perm rating <0.15.
Concrete	Above or on	Concrete	Solid or engineered	Floating	N/A	N/A	6.II.A & B	Roll or sheet membrane: i.e., min. 6 mil poly C&A film or superior ASTM D1745 membrane. Foam pad, vented or other membrane.	A) ASTM E96 B) Follow the floor manufacturer's recommendations	Min. ≤ 0.15 Best ≤ 0.02	Vapor retarder seams must be sealed with an impermeable material with a perm rating <0.15.
Concrete	Above or on	Plywood/OSB Plywood/OSB	Solid or engineered	Plywood floating/nail down	N/A	N/A	*Floating plywood systems* 6.II.D.two-layer method or 6.II.E. single-layer method *Nail-down plywood* 6.IV.A-D	Roll or sheet membrane: i.e., min. 6 mil poly C&A film or superior ASTM D1745 membrane. Foam pad, vented or other membrane.	A) ASTM E96 B) Follow the floor manufacturer's recommendations	Min. ≤ 0.15 Best ≤ 0.02	Vapor retarder seams must be sealed with an impermeable material with a perm rating <0.15.

Job Site Platform	Grade Level	Subfloor Material	Flooring Type	Floor Installation Method	Adhesive Product Type	Adhesive Application	NWFA Guideline	Acceptable Vapor Retarder	NWFA Membrane Standard	ASTM E96 Required Perm Rating	Note: Always follow manufacturer, specifier and/or local code requirements. Installation of a vapor retarder reduces the potential for, but does not guarantee elimination of, moisture or vapor related problems.
Concrete	Below	Plywood/OSB Plywood/OSB	Engineered only	Plywood floating/nail down	N/A	N/A	*Floating plywood* 6.II.D.two-layer method or 6.II.E. single-layer method *Nail-down plywood* 6.IV.A-D	Roll or sheet membrane: i.e., min. 6 mil poly C&A film or superior ASTM D1745 membrane. Foam pad, vented, dimpled or other membrane.	A) ASTM E96 B) Follow the floor manufacturer's recommendations.	Min. ≤ 0.15 Best ≤ 0.02	Vapor retarder seams must be sealed with an impermeable material with a perm rating <0.15.
Concrete	Above, on or below grade	Screeds with plywood or OSB over concrete	Solid or engineered (engineered only below grade)	Screed system	N/A	N/A	6.V. A-D; see also Appendix I	Roll or sheet membrane: i.e., min. 6 mil poly C&A film or superior ASTM D1745 membrane.	A) ASTM E96 B) Follow the floor manufacturer's recommendations.	Min. ≤ 0.15 Best ≤ 0.02	Vapor retarder seams must be sealed with an impermeable material with a perm rating <0.15.
Concrete	Above, on or below grade	Concrete	Solid or engineered	Glue down or float	Urethane	Troweled	5.i.B3-4 6.i.A-B 6.iii.A-B	All should reduce vapor transmission to 3lbs, or 75% RH or less.		ASTM E96	
Concrete	Above, on or below grade	Concrete	Solid or engineered	Glue down or float	Urethane and adhesive	Troweled	5.I.B3-4 6.I.A-B 6.III.A-B	All should reduce vapor transmission to 3lbs, or 75% RH or less.		ASTM E96	
Concrete	Above, on or below grade	Concrete	Solid or engineered	Glue down or float	MS	Troweled	5.I.B3-4 6.I.A-B 6.III.A-B	All should reduce vapor transmission to 3lbs, or 75% RH or less.		ASTM E96	
Concrete	Above, on or below grade	Concrete	Solid or engineered	Glue down or float	Epoxy	Rolled	5.I.B3-4 6.I.A-B 6.III.A-B	All should reduce vapor transmission to 3 lbs, or 75% RH or less.		ASTM E96	

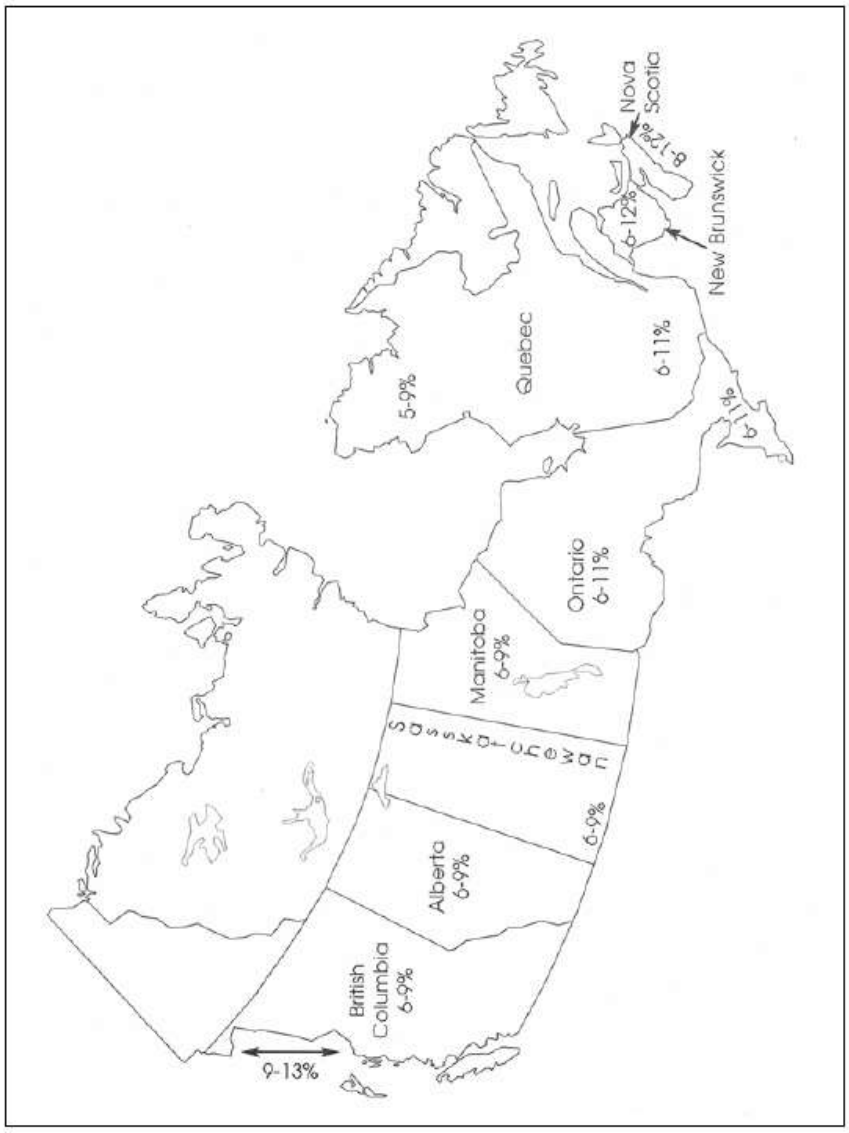
Part V
Dimensional Change of Coefficients

A. See Chapter 2, Solid Strip and Plank Flooring Installation, for dimensional change of coefficients.

Part VI
Moisture Content by Area



Note: Relative humidity in the building should be maintained at between 30-50 percent year-round. A consistent interior climate environment is the key to optimum wood flooring performance.



Note: Relative humidity in the building should be maintained at between 30-50 percent year-round. A consistent interior climate environment is the key to optimum wood flooring performance.