APPENDIX C
MOISTURE GUIDELINES
& MOISTURE TESTING

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.

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.

Moisture Testing for Wood Flooring and Wood Subfloors

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 determine if floor boards are dry enough for an installation to proceed. They can check subfloors and concrete for high moisture levels; they can decide when a second coat of finish can be applied; they can assess water damage.

There are two main types of meters for testing wood – probe and pinless.

• 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.

One advantage of probe-type meters is that those with insulated pins can measure moisture content at varying depths – you can tell whether the moisture content near the bottom of a board is higher than near the top, for example.

• The pinless, dielectric types employ signal penetration up to 1 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 coating, varnish or paint without damage to the surface. Because pinless moisture meters often measure deeper than the ¾" depth of the wood flooring, the moisture readings from the meter may include moisture in the wood subfloor, as well as in the wood flooring. 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.

It is important that the meter you choose offers the following:

• A wide moisture content range from at least 6 percent to 30 percent.

• The necessary adjustment tables or conversion chart 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. Pay special attention to exterior and plumbing walls. In most regions, a "dry" subfloor that is ready to work on has a moisture content of 12 percent or less. If you record excessively high readings, do not proceed with installation until the origin of the moisture is identified and moisture problems are remedied.

Moisture Testing For Concrete Slabs:

Note: Before moisture testing begins, the concrete slab must be a MINIMUM of 30 days old.

Moisture meters for concrete can be probe-type or pinless. Some meters designed to provide qualitative results – that is, the readings they provide can indicate potential moisture problems, but will not provide a definitive reading. In that case, quantitative testing is required.

The two qualitative moisture meters work on the principles of electrical impedance or electrical resistance. 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. 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 F-2170), calcium chloride testing (ASTM F-1869) or calcium carbide (CM) testing. (See below.)

Another qualitative test is the phenolphthalein test, which requires one test per 200 square feet of surface area, with a minimum of two tests per jobsite. Chip a small section of concrete off the floor and apply 3 percent phenolphthalein in alcohol solution (available at most druggists) in the area. A red color indicates that moisture is present. Always chip the concrete as this protects against the possibility that a concrete sealer was applied. If the phenolphthalein test indicates the presence of excessive moisture, further testing is required using relative-humidity testing (ASTM F-2170), calcium chloride testing (ASTM F-1869) or calcium carbide (CM) testing. (See below.)

Quantitative Moisture Tests on Concrete

Relative Humidity Testing - ASTM F-2170

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.

Perform three tests for the first 1,000 sq ft and one test for every additional 1,000 sq ft thereafter.

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.

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.**

Allow 72 hours to achieve moisture equilibrium within the hole before making relative humidity measurements.

ASTM F-710 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.

Calcium Chloride Test - ASTM F-1869

Select test locations to provide information about moisture distribution across the entire concrete floor slab.

Perform three tests per 1,000 square feet of surface area. Add one additional test for each 1000 square feet thereafter.

At least 48 hours before test is placed, concrete floor slabs should be at the same temperature and humidity expected during service conditions

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.

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.

Follow manufacturer's instructions for properly placing tests onto concrete.

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.

Send the test to a certified laboratory for results and documentation, or perform the measurements as per ASTM F-1869.

Always following the flooring manufacturer's guidelines and specifications to determine when the concrete slab is ready for installation.

ASTM F-710 provides installation guidelines for acceptance of hardwood flooring using calcium-chloride testing. Typical limits for direct glue-down wood flooring is 3lbs/1000sf/24hr. When getting readings over 3 lbs and up to 7 lbs, you must use a vapor retarder. A reading over 7 lbs 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 U.S. or 800-848-8824 Canada for the source nearest you.

Calcium Carbide (CM) Test - ASTM (modified) D-4944-04, MilSpec CRD-C154-77

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 over 2.5% requires use of a vapor retarder. A reading over 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.

The testing method generally requires the collection of specific weighed quantities of concrete from the floor by chipping or drilling. A specific quantity of carbide is added, as well as two or more steel balls and the chamber is sealed. The materials are rolled or shaken to mix and to allow the steel balls to pulverize the test materials. Carbide reacts with moisture in the test materials creating acetylene gas that is measured on an attached pressure gauge.

Acceptable Vapor Retarders Over Wood Subfloors

ALWAYS FOLLOW LOCAL CODES AND MANUFACTURERS INSTRUCTIONS FOR ACCEPTABLE VAPOR RETARDERS.

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 50 when tested in accordance with ASTM E-96 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 sub-floors prior to installing nail down solid strip or plank flooring. Over-lap seams a minimum of 4 inches or more as required by manufacturer or specifier and local building codes.

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 that meets ASTM Standard D-4869 or UU-B-790, Grade D.

NOTE:

1. A vapor retarder has some extra benefits in that it eliminates wood-on-wood contact, wood boards slide more easily when positioned, minimizes the impact of seasonal humidity change and 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 in all applications. The 2006 International Residential Code requires a vapor retarder on the warm-in-winter side of exterior floors (a floor over a vented crawl space, for example), with a vapor permeance of 1 perm or less in Zones 5 and higher.
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.
4. Do not use common red rosin or building paper which is not asphalt saturated. They are not vapor retarders as their perm rating is far greater than 50.

Acceptable Vapor Retarders Over Concrete

A. ALWAYS FOLLOW LOCAL CODES AND MANUFACTURERS INSTRUCTIONS FOR ACCEPTABLE VAPOR RETARDERS.

B. Test concrete for moisture. For concrete slabs with a calcium chloride reading of greater than 3 lbs, 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 3 lbs 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 2006 International Residential Code defines a vapor retarder as a vapor-resistant material, membrane or covering such as foil, plastic sheeting or other material

recommended by the manufacturer having a permeance rating of 1 perm or less, when tested in accordance with ASTM E-96 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, with perm of .13, or other impermeable material with a perm of .15 or less is recommended. A premium polymer material meeting ASTM D-1745 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 D-4869, with the first layer adhered to the slab in a skim coat of appropriate adhesive, and a second layer adhered to the first layer with 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.