



SOLID HARDWOOD INSTALLATION GUIDELINES

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JOHNSON PREMIUM HARDWOOD FLOORING®
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STOP! IMPORTANT INFORMATION

GUIDELINE DISCLAIMER: COMPLETELY READ AND UNDERSTAND THESE GUIDELINES BEFORE INSTALLATION BEGINS. FAILURE TO DO SO CAN/WILL RESULT IN THE FOLLOWING DAMAGE TO YOUR WOOD FLOOR: CUPPING, WARPING, TWISTING, BOWING, BUCKLING, SHRINKING, DELAM, GAPPING, CHECKING, CRACKING, SPLITTING, DISCOLORING, EARLY WEAR, DENTING, SCRATCHING, HOLLOWES, AND RELEASING FROM THE SUBFLOOR. FAILURE TO ABIDE BY THESE GUIDELINES CAN/WILL VOID ANY/ALL WARRANTIES JOHNSON HARDWOOD OFFERS WITH THIS PRODUCT.

Prior to installing Johnson Hardwood solid wood flooring; materials **MUST** be tested for recommended moisture content. Job site temperature and relative humidity levels **MUST** also be carefully measured and recorded daily during the installation process. The homeowner **MUST** maintain the temperature and relative humidity level in the recommended ranges (60 to 80f and 35 to 50 rh) to ensure maximum performance.

OWNER/INSTALLER RESPONSIBILITY

Hardwood flooring is a beautiful product of nature, which is characterized by distinctive variations in grain and color. These variations in color and grain should not be seen as flaws, but embraced as nature displays its beauty and uniqueness. Johnson Hardwood flooring are manufactured according to accepted industry standards, which permit a defect tolerance of 5%.

Product Quality: The contractor/installer/end-user assumes all responsibility for final inspection of product quality. The flooring **MUST** be inspected at time of delivery and prior to installation. Carefully examine the flooring for moisture content (6.8 to 9.4%), color, grade, finish quality or any damage during transit **before** installing it. The installer should use reasonable selectivity to cull out or cut off unacceptable pieces. If the flooring material is considered unacceptable, “**STOP DO NOT INSTALL THE FLOOR**”, but contact the Johnson Hardwood dealer immediately. Once the flooring is installed, there is no question as to its acceptability. Note: There is an allowance of 5% for the material to have moisture content as high as 12.0%. This is an industry standard.

Environment: Prior to installation, the installer **MUST** determine that the environment of the job site and the conditions are suitable to the material that is being installed. The installer is responsible for determining the moisture emission rate of the concrete slab and/ or the moisture content of the CDX plywood or better sub floor as per the National Wood Flooring Association (NWFA) installation guidelines, SECTION V – Appendix AA Moisture Testing Procedures for Concrete Slabs, (specifically the Calcium Chloride test) and Appendix AB Moisture Testing for Wood. All test results **MUST** be carefully **documented** and made available/presented to the homeowner prior to installing the flooring. Johnson Hardwood declines any responsibility for job failure from or associated with inappropriately or improperly prepared subfloors or job site environment deficiencies. Also, Johnson Hardwood “HIGHLY” recommends that the installer/contractor take daily readings of the ambient conditions of the environment in which the flooring will be installed i.e. temperature and relative humidity levels and record the results on a daily log sheet as well as take periodic moisture readings of the wood floor and sub floor during the installation process and record the results of those readings as well.

Waiver: Unless a waiver or letter of protest listing exceptions exists, installation constitutes acceptance of subfloor/substrate, the job itself – including the ambient temperature and relative humidity at the time of installation, and all impacting variables that may affect a wood floor.

Informing the Homeowner: Homeowner(s) **MUST** be made aware of color variations, graining ranges, the effect that moisture has on wood flooring; the importance of maintaining a controlled environment (60 to 80f and 35 to 50rh respectively) before, during and after the installation for the life of the floor. Also, the proper way in which to maintain wood floors and the effect that UV light has on wood, **especially exotic woods**. All products from Johnson Hardwood will change color over time. The degree of change depends on the species and

the amount of UV exposure. Typically speaking, wood usually darkens over time however; some wood species will actually lighten when exposed to UV light.

The homeowner **MUST** be made aware of the effect that moisture has on wood flooring e.g. moisture gain can result in cupping, buckling, cracking, splitting, checking, warping, wear-layer delam, separation from the sub floor and possible damage to surrounding walls, tile/stone floors and cabinetry etc. On the other hand, moisture loss can result in splitting/separation of the segments, gapping, surface and or end checking and everything else mentioned with moisture gain. Moreover, the importance of maintaining a controlled environment (60 to 80f and 35 to 55rh respectively) before, during and after the installation for the life of the floor. Also, the proper way in which to maintain wood floors. REFER TO CLEANING SECTION.

Blending Rule: Where wood flooring transitions into support moldings i.e. stair treads, stair nosing's, reducer's, T-molds, end-caps etc., pick boards that better blend to the color tone of the molding so that you don't end-up with a drastic change in color. Your goal is to gradually transition into the molding so as not to have a distinct color variance between the wood floor and the trim moldings.

Inspect Flooring: Verify that the delivered flooring has 6.8 to 9.4% moisture content and is free of defects.

During Installation: It is the installer's responsibility to protect the flooring from any/all damage i.e. dings, dents, scratches etc. Installation/construction related damages are **NOT** covered under Johnson Hardwood's structural and or finish warranties.

Wet Work: All wet work such as plastering, painting and any/all masonry or tile work **MUST** be completed prior to delivering the flooring to the job-site.

Delivery/ Storage: **NEVER** deliver wood flooring during adverse weather conditions such as rain and or snow unless the flooring can be completely and thoroughly protected from getting wet and or gaining moisture during transit to the job-site. **NEVER** store wood flooring in an "uncontrolled environment" e.g. patios, drive ways, garages, sheds, storage units, or even in the structure in which the flooring will be installed. Deliver the flooring to the job-site **ONLY** when a controlled environment has been established according to Johnson Hardwood/NWFA requirement/recommendations.

JOB SITE INSPECTION AND PRE-INSTALLATION REQUIREMENTS

Note: In newly constructed buildings, wood flooring should be one of the last items installed. All work involving water or moisture **MUST** be completed prior to the delivering of flooring to the job site. In addition, all doors and windows **MUST** be installed and weather striping in place. Additional information can be found in the National Wood Flooring Association's Technical Publication No. A100 Water and Wood. "How Moisture Affects Wood".

Moisture: Job site must be dry with no visible moisture. To ensure the job site is ready for hardwood flooring, installer **MUST** conduct necessary moisture tests (i.e. calcium chloride test(s) for concrete slabs following ASTM F-1869-4 for installations over wood sub-floors). All testing results **MUST** be carefully **recorded** and made available to the homeowner **before** any work begins. Electronic moisture meters designed to measure moisture content in concrete slabs are **NOT** recognized by Johnson Hardwood as a viable way to determine if a moisture vapor retarding system is needed/necessary prior to installing the floor.

Job-Site Evaluation: Contractor/installer **MUST** perform a pre-installation job site evaluation. The contractor/installer **MUST** determine the following: Does the lot/structure sit on an alluvial plain? If so, is water run off directed away from the side of the building? Does the roof gutter system direct water to a main drainage system that carries water away from the side of the building? Is there adequate drainage around all landscape and hardscape to carry water away from the side of the building? Also, check the surrounding concrete walkways and driveways for signs of efflorescence and alga growth. Check surrounding planters for over watering as well as make sure sprinklers are directing water spray away from the side of the building.

HVAC System: As recommended by the National Wood Flooring Association (NWFA) as well as Johnson Hardwood, the installation site **MUST** have a consistent room temperature of 60 to 80 degrees Fahrenheit and 35 to 50 percent relative humidity respectively. The structure **MUST** be fully enclosed with interior climate controls operating for at least **5 days** before delivering flooring to the jobsite. Moreover, recommended temperature and humidity levels **MUST** continue during and after installation for the life of the floor. If heating/air-conditioning/humidification systems are in operating condition, they need to be operating. If it is not possible for the permanent heating/air-conditioning/humidification systems to be operating before, during and after installation, a temporary heating/air-conditioning/humidification system that mimics "manufacturer" specified temperature and humidity conditions can enable the installation to proceed until a permanent heating/air-conditioning/humidification system is operating.

Subfloor: The sub floor **MUST** be free from any type of paint, oil, grease, dust, drywall mud, sealers, release agents and all other types of residues/contaminates.

Floor Flatness: The subfloor should be level in general however; it **MUST** be flat to within ¼" over a 10-foot radius, in all directions.

Crawl Space: The soil within the crawl space **MUST** be covered with “black” 6-mil polyethylene sheeting overlapping the seams a minimum of 12” followed by Duct taping the seams the entire length of the over-laps. Make sure to run the poly-sheeting up the stem wall 4 to 6” but DO NOT tape, this will allow for “controlled” evacuation of gaseous water vapors into the crawl space atmosphere, which in turn should be carried out through the venting system. Per industry standards in order to foster proper airflow there **MUST** be at least 1 ½ vents for every 100 sq. ft. of crawl space area. The distance between the surface of the soil and the bottom of the sub floor should/must have a clearance of 18 to 24 inches. **It is the installer’s responsibility to determine (prior to installing the flooring) that the perimeter of the crawl space contains the correct amount of vents for the size of the crawl space and that no vents have been blocked i.e. masonry concrete patios,etc.) Local building codes may differ. Follow local building codes. See Figure 1-1.** It is not uncommon to have as much as 14 to 17 gallons of water emitting from the soil in a 24-hour period, over 1000 sq. ft. crawl space. Moisture related failures resulting from not covering the crawl space soil with 6-mil poly sheeting **will not** be warranted by Johnson Hardwood.

Undercut Door Casings and Jambs: Undercut all door casings and jambs 1/16” higher than the thickness of the “finished” flooring being installed. You can achieve this by using a hand jamb saw using a piece of the flooring as your height gauge or use an adjustable power jamb saw adjusted to the appropriate height.

SUB FLOOR REQUIREMENTS

Concrete Slab: The concrete sub floor must be dry. Newly poured Concrete slabs will require a 90 to 150 day drying period depending on the size and depth of the slab and weather conditions. **Note: Before moisture testing can begin, the concrete MUST be allowed to dry for a minimum of 30 days. If moisture testing begins before the minimum 30-day drying period, the test results will be inaccurate and unreliable. Please follow ASTM standard F-1869-4 which is the specific preparation/application instructions for calcium chloride testing.**

Mechanical Fastening: When mechanically fastening an industry/multiplier approved sub floor (3/4” CDX plywood or better) to the surface of a concrete slab (which results in perforating the moisture vapor retarding system), the maximum allowable moisture emission rate cannot exceed 7 pounds per 1,000 sq. ft. per 24 hours based on the calcium chloride test. **Floor Flatness:** The subfloor should be level in general however; it **MUST** be flat to within ¼” over a 10-foot radius, in all directions. Subfloors that are outside the acceptable tolerance range can be surface ground or patched depending whether the flatness issue is a rise in the subfloor or a dip. For low areas, we recommend a good Portland base cement product such as the Ardex brand. For questions as to which one of the many Ardex products should be used for your particular need, contact Ardex directly at 888-512-7339 and ask for technical support.

Plywood Sub-Floor: If plywood is used as a subfloor, the moisture content difference **MUST NOT** exceed more than 2% between the finished wood floor and the plywood subfloor. All plywood **MUST** be exterior grade CDX or better. Plywood size for subfloor is suggested to be standard ¾”x4’ x8’ panels, with an expansion gap of ¼” between panels, and stagger full sheets by ½. Cross kerf the back of each panel every 1’ x 3/8” deep. **Plywood subfloor should run at a 45 degree angle(preferred) or perpendicular to the direction of the finished wood floor.**

CDX Plywood: CDX plywood when properly installed over the surface of a concrete slab or lightweight concrete sub straight (following manufacturer guidelines/industry standards), it is **strongly recommended** that the plywood be covered with an additional layer of 15 lb. or 30 lb. tar saturated felt paper, or an asphalt laminated paper meeting UU-B-790a, Grade B, I, Style 1a., prior to installing the floor.

Raised Foundation: Ground level of the raised foundation sub floor **must** be completely covered with an industry approved moisture vapor retarding system such as 1 layer of 15 lb. or 30 lb. tar saturated felt paper, or an asphalt laminated paper meeting UU-B-790a, Grade B, Type I, Style 1a. Installations over raised foundations (joist type or pier and beam type construction) must conform to the following requirements: Joist span of 16” on center requires a “minimum” of 5/8” CDX plywood; 19.2” span requires a minimum of ¾” CDX and 24” spans require a minimum of 1” interlocking tongue and groove CDX plywood.

Newly Constructed Building: In newly constructed buildings, hardwood flooring should be one of the last items installed. All work involving water or moisture **MUST** be completed prior to the delivering of wood flooring to the job site. In addition, all doors and windows must be installed and weather striped.

HVAC System: **NEVER** turn off the Heating Ventilation Air-conditioning or humidification (HVAC) system when you’re away from your home/building i.e. during vacation time periods. If you do, you may return to a floor that is cupped, or has a severe case of shrinking/gapping, splitting, and/or checking.

Grade Level: Johnson Hardwood's solid wood flooring is designed to be installed on the following grade levels: on and above grade only. **Note: If any part of the soil surrounding the structure is 3” above the floor of any level, consider that level below-grade.**

Cleaning: During routine maintenance, **DO NOT** clean your floor surface with oil soaps, sprays of any kind (which usually contain silicone oil or wax), water, Windex and water, vinegar and water, waxes of any kind, conditioners, surface refreshers (which usually contain polyurethane), solvents of any kind, **non** recommended flooring cleaners such as, Swiffer Wet Jet or any other like cleaning product. **Only use cleaning products that are specifically recommended and or approved by Johnson Hardwood i.e. Bruce Armstrong hardwood/**

laminate cleaner, Mannington hardwood/laminate cleaner, Basic Coatings “Squeaky” Clean hardwood/laminate cleaner and Bona hardwood/laminate cleaner. For more information on how to properly maintain your Johnson Hardwood floor, please see our maintenance guideline on our web site www.johnsonhardwood.com and go to the customer support section.

Protective Glides: Place protective glides on the bottom of all chairs and furniture legs; they come in a variety of sizes and shapes and can be purchased at your local home improvement center. For your really large furniture such as China cabinets and hutches etc., you will definitely need to use protective glide pads that are designed to cover a larger area so as to better protect the flooring from scratches and/or gauges. For pianos use piano coasters.

Radiant Heat: JOHNSON HARDWOOD SOLID WOOD PRODUCTS **CANNOT BE INSTALLED OVER RADIANT HEATED SUBFLOORS.**
Informing the Homeowner: The dealer and contractor/installer are responsible for informing the builder and or the homeowner of the importance of maintaining a controlled environment before, during and after the installation of flooring in order to maintain the physical and structural condition of the floors.

Box Rule (3-5): When installing Johnson Hardwood flooring it is recommended to work out of 3 to 5 boxes at a time to achieve a more uniform color tone and grain appearance throughout the installation.

Blending Rule: Where wood floor transitions into support moldings (i.e. nosing’s, reducers etc.), pick boards that better blend to the color tone of the molding so that you don’t end-up with a drastic change in color. Your goal is to gradually transition into the molding so as not to have a distinct color variance between the wood floor and the trim moldings.

Inspect Wood: Verify that the delivered wood flooring has 6.8 to 9.4% moisture content and is free of defects.

Equilibrium Chart: Atmospheric conditions **MUST** be maintained within the recommended range in order to maintain optimal dimensional performance of your wood floor. To determine the suitable moisture content for installation, please use the equilibrium moisture chart provided below. Grayed area represents the ideal moisture content for the wood to perform normally. Moisture tests **MUST** be conducted **before, during and after** the flooring has been installed. **Additional information can be found in the National Wood Flooring Association’s Technical Publication No. A100 Water and Wood. “How Moisture Affects Wood”.**

Wet Work: All wet work such as plastering, painting and any/all masonry or tile work **MUST** be completed prior to delivering the wood to the job-site.

Equilibrium Moisture Content Chart: Temp. (F) Relative Humidity Percent

Relative Humidity%	Ambient Air Temp (Deg. F)							
	30°	40°	50°	60°	70°	80°	90°	100°
5	1.4	1.4	1.4	1.3	1.3	1.3	1.2	1.2
10	2.6	2.6	2.6	2.5	2.5	2.4	2.3	2.3
15	3.7	3.7	3.7	3.6	3.5	3.5	3.4	3.3
20	4.6	4.6	4.6	4.6	4.5	4.4	4.3	4.2
25	5.5	5.5	5.5	5.4	5.4	5.3	5.1	5.0
30	6.3	6.3	6.3	6.2	6.2	6.1	5.9	5.8
35	7.1	7.1	7.1	7.0	6.9	6.8	6.7	6.5
40	7.9	7.9	7.9	7.8	7.7	7.6	7.4	7.2
45	8.7	8.7	8.7	8.6	8.5	8.3	8.1	7.9
50	9.5	9.5	9.5	9.4	9.2	9.1	8.9	8.7
55	10.4	10.4	10.4	10.2	10.1	9.9	9.7	9.5
60	11.3	11.3	11.3	11.1	11.0	10.8	10.5	10.3
65	12.4	12.4	12.4	12.1	12.0	11.7	11.5	11.2
70	13.5	13.5	13.5	13.3	13.1	12.9	12.6	12.3
75	14.9	14.9	14.9	14.6	14.4	14.2	13.9	13.6
80	16.5	16.5	16.5	16.2	16.0	15.7	15.4	15.1
85	18.5	18.5	18.5	18.2	17.9	17.7	17.3	17.0
90	21.0	21.0	21.0	20.7	20.5	20.2	19.8	19.5
95	24.3	24.3	24.3	24.1	23.9	23.6	23.3	22.9
98	26.9	26.9	26.9	26.8	26.6	26.3	26.0	25.6

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

Required Tools and Accessories for Nail Down Installations:

Please refer to the National Wood Flooring Association's Technical Publication N0. A300 Tools of the Trade. "What Contractors Need for Hardwood Flooring Installation".

INSTALLING A PLYWOOD SUBFLOOR SYSTEM OVER A CONCRETE SLAB

There are (3) commonly used methods to construct a plywood base subfloor and vapor retarding system over the surface of a concrete slab.

Mechanical Fastening

After determining the moisture emission rate (based on the calcium chloride test) does not exceed 7 lb. in 24 hours over 1,000 sq. ft. of surface area, you are now ready to begin building your sub floor system:

WARNING: IT IS THE INSTALLER/CONTRACTORS RESPONSIBILITY TO DETERMINE THE SLAB TYPE, (I.E. POST TENSION). IF IT IS, USE EXTREME CAUTION WHEN USING PENETRATING FASTENERS TO SECURE THE SUB FLOOR TO THE SLAB SO THAT A FASTENER IS NOT DRIVEN INTO A CABLE. THE CONSEQUENCES COULD BE QUITE DESTRUCTIVE, RESULTING IN DAMAGE TO THE SLAB AND OR STRUCTURE AND QUITE POSSIBLY, EVEN BODILY INJURY!

Method #1: (1) Using a 1/8" v-notch trowel apply a skim coat of Cold Stick tar (i.e. Cold Stick P-84 by Pure Asphalt Co.), or equivalent over the surface of the concrete slab in sections; (2) apply a layer of 6-mil polyethylene sheeting over the tar making sure to over-lap seams a minimum of 12 inches; (3) duct taping seams together as you go; (4) apply 1-layer of 15 lb. tar saturated felt paper over the surface of the poly sheeting making sure to over-lap the seams of the 15 lb. felt paper by a minimum of 4 to 6 inches; (5) Duct taping the seams together as you go.

Method #2: (1) Seal the surface of the slab using a manufacturer approved 2-part epoxy sealer and let dry overnight or according to the recommendations of the sealer manufacturer; (2) using a 3/16" v-notch trowel apply a coat of Cold Stick P-84 tar by Pure Asphalt Co., or equivalent over the epoxy sealer in rows 4" wider than the width of the 15 lb. tar saturated felt paper, this is to ensure that the slabs surface is completely covered with tar; (3) roll out the felt paper into the freshly applied tar making sure that the felt paper is cut net to all vertical obstructions; (4) spread out another row of tar making sure to overlap the edge of the tar paper with tar, 4 to 6 inches so that when you overlap the next row of paper by 4 to 6 inches you will essentially be gluing them together; (5) repeat this process until you have completely covered the slabs surface with tar and felt paper; (6) then repeat the entire process applying tar and felt paper over the first layer of tar and paper, however this time the starting row of the second layer will need to be offset by half until you have covered the first layer of tar and paper completely. Make sure to go back to the initial starting row on layer #2 and cover the missing row with tar and paper remembering not to forget to coat and over-lap the seam.

Panels: Using a minimum thickness of 3/4" CDX or better plywood kerf the back of the panel to a depth of half its thickness 1 foot apart. This will help in taking the tension out of the panel. Then cut the plywood panels so that you cover all areas of installation, allowing for a 1/4" gap along all edges of the panels, and 3/4" around all vertical obstructions, as well as the perimeter of the room. You are now ready to secure/ fasten the panels to the substrate using concrete screws, powder or pneumatically driven concrete pins/fasteners 1 1/4" to 1 1/2" long. The recommended fastening schedule is 1-pin per sq. ft. which equates to 32-pins per 4' x 8' panel spaced out equally throughout the panel with the perimeter pins positioned 1" to 1 1/2" inches from the edges of the panel.

Method #3 (Floating Sub-Floor): After determining that the moisture emission rate (based on the calcium chloride test) does not exceed 7 lb. in 24 hours over 1,000 sq. ft. of surface area, you are now ready to begin building your system.

(1) Construct a vapor retarding system using either method #1 or #2; (2) attach 2-sheets of 3/8" cdx plywood together (cross directional or at a 45° angle to one another) using construction adhesive (non water base), leaving a 1/4" gap between all seams, applied in a serpentine pattern 4 to 6 inches apart; (3) screw the panels together spacing every 6 to 8 inches around the perimeter and 10 to 12 inches in the field. Make sure the screws do not extend through the bottom of the second sheet of plywood, by doing so could compromise the effectiveness of the vapor retarding system, which could result in a moisture related distress failure.

Glue-down Subfloor: Using 3/4" CDX or better plywood, always follow the adhesive manufacturer's recommendation for proper application, proper adhesive and correct trowel notch configuration and spread rate before commencing with the installation.

IMPORTANT: Prior to installing Johnson SOLID Hardwood Flooring, materials must be tested for recommended moisture content. Jobsite temperature and relative humidity levels must also be carefully monitored and recorded daily during the installation process. The homeowner must maintain the temperature and relative humidity level in the recommended ranges to ensure maximum performance.

ACCLIMATION

Acclimation depends on geographic location, interior climate control and time of the year. 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 interpreted to mean 35 to 50% relative humidity and 60 to 80 degrees Fahrenheit respectively.

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 do not reflect those normal environmental conditions. Garage and exterior patios, for example, are not acceptable areas to store wood flooring.

Wood flooring is a hygroscopic material subject to dimensional change because of variations in moisture, temperature and humidity in the surrounding environment. That has led to increasing awareness of the need to 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 the time of year and geographic location.

COEFFICIENTS OF CHANGE: HOW MOISTURE AFFECTS WOOD FLOORING

Reference back to the EMC chart, at 70 degrees 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 2 ¼-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.

WOOD'S COMFORT ZONE

As a general rule, wood flooring will perform best when the interior environment is controlled to stay within a relative humidity range of 35 to 50 percent and a temperature range of 60 to 80 degrees Fahrenheit. The chart above 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 6.8 to 9.4 percent range within which most hardwood flooring is manufactured. Although some movement can be expected even between 6.8 and 9.4 percent, wood can expand and shrink more dramatically outside that range. 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, equilibrium moisture content (EMC) has been reached.

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 the 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 an HVAC system.

For example, if a wood flooring installation takes place at a time of year when relative humidity is high, it is likely that the wood flooring will lose moisture content and therefore shrink during low-humidity seasons. In that case, the knowledgeable installer will install the flooring as tightly as possible (being mindful not to damage the floor in the process), thereby minimizing the expected (and normal) separations that will occur between boards as the boards shrink during heating or other dry seasons.

Conversely, if a wood flooring installation takes place during a time of year when humidity conditions are low, it's likely that the wood flooring will gain moisture and therefore expand during more-humid seasons. In those cases, a knowledgeable installer will incorporate additional expansion space throughout the floor, 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, as well as on the expected variations in temperature and humidity at the location.

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 (<http://www.weather.gov>) and Weather Underground (www.wunderground.com).

Calculating dimensional changes: 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 several 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 the flooring is to be installed. Finally, you will need to know the dimensional change coefficient of the species to be installed. For additional help contact Johnson's technical department at 800-910-3047.

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 of 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 the 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 degrees). 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:

$.00369 \times 3 \times 5 = .055$ inches

In other words, for every 3-percentage-point increase in moisture content, a 5-inch board will grow by more than $\frac{1}{20}$ th of an inch. Over 10 boards that will equal over $\frac{1}{2}$ 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

- 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 outside the range of conditions specified by the wood flooring manufacturer/Johnson Hardwood. In fact, it is counterproductive.
- Where building codes allow, permanent HVAC 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 is interpreted to mean 35 to 50% relative humidity and 60 to 80 degrees Fahrenheit respectively.
- If it is not possible for the permanent HVAC system to be operating before, during and after installation, a temporary heating and humidification/dehumidification system (using electric heating units), and industrial fans can enable the installation to proceed until the permanent HVAC system is operating.
- Upon delivery, check wood flooring moisture content with an approved/calibrated (preferably a resistance/ pin type) moisture meter to establish a baseline for required acclimation. Acclimation can be facilitated by breaking the floor units into small lots and/or opening the packaging. A common practice is to stack and sticker the flooring, with $\frac{3}{4}$ -inch to 1-inch sticks between each layer of flooring to allow air circulation on all side of all boards. **However, this common practice is not recommended for exotic species due to the perceive color changes and possible striping perpendicular to the direction of the grain once the stickers are removed.**

INSTALLING THE FLOOR

Meter the moisture content level of the flooring again and make sure it has stabilized with the surrounding **controlled environment** based on 35 to 50 percent relative humidity and 60 to 80 Fahrenheit. **Please note an uncontrolled environment can lead to the following conditions: Shrinkage/gapping, cupping, buckling, checking or splitting. Johnson Premium Hardwood will not warrant any damages caused by moisture/atmospheric related causes.**

Box Rule (3-5): Before beginning the actual installation, provide proper layout of flooring by working out of multiple boxes of material (3 to 5) is recommended in order to achieve a more uniform color tone, and grain appearance throughout the installation.

Expansion Space: Allow at least (3/4" minimum) of expansion space at all wall and vertical obstructions. Expansion space will be concealed using baseboard and quarter round trim will change in size according to changes in the ambient conditions within the structure i.e. temperature and relative humidity levels. **Insufficient expansion space can result in buckling, cracking and checking in the flooring. Johnson JHardwood will not warrant any damages caused by improper installation.**

Starting Line: Snap a working line parallel to the starting wall, in multiples of the planks width, **plus** an expansion space of $\frac{3}{4}$ " to set up the base baseline of installation. Be careful to assure you do NOT end up with a width of less than 2 inches at the final opposing wall. If so, adjust by ripping down the width of the first row. **Note:** For questions on how to square out a room, contact Johnson Hardwood's technical department at 800-910-3047.

Backer Board: Install a backer board along your initial starting line, this will provide needed support for the first 3 to 4 feet of flooring installation. Backer boards are typically made from $\frac{1}{2}$ " to $\frac{3}{4}$ " (MDF) Medium Density Fiber Board cut into pieces 4 or 5 inch wide by 8-feet long. Secure the backer board to the sub floor using the appropriate length fasteners (deck screws for raised foundation applications and Tap Con screws for applications over concrete slabs) being careful not to exceed the thickness of the raised foundation sub floor.

NAIL-DOWN INSTALLATION

IMPORTANT: Be sure not to over drive the fastener past the nail slot, this can lead to a condition known as a telegraphing fastener. A telegraphing fastener is the visible effect of excessive pressure being placed on the wood fibers which causes the appearance of a bump to occur on the boards surface just above the fasteners. This condition becomes most apparent when natural or artificial light reflects across the surface of the floor causing the bump to become visible to the eye. This condition can sometimes be difficult to see, so make sure to examine the first few rows of flooring to assure telegraphing does not exist. Johnson Hardwood flooring does not warrant against this condition since telegraphing fasteners are not manufacturing related. If you should encounter this problem, immediately stop the installation and contact Johnson Hardwood's Technical Department and or the manufacturer of the nailer for technical advice. It is essential that the flooring installer make sure that the nailer/stapler is properly adjusted for the particular floor that is being installed(i.e. the fastener(s) MUST enter the nail slot at the correct angle and height). Do not over-drive the fasteners so as not to cause damage to the board (e.g. telegraphing fasteners, broken or split tongues, squeaking, or crackling noise).

Fastener Gauge: For nail down installations the tongue should be facing away from the backer board, the board is then secured to the sub floor by means of either using a ½" 16-gauge crown staple, or **preferably** the 18 or 16-gauge Power cleat manufactured by Power Nail Co. Be vigilant for any signs of Telegraphing Fastening for the reasons previously stated. Note: if you find that 16-gauge cleats or staples are splitting/breaking the board's tongues, try using the 18-gauge Power cleat since it places less pressure of the woods fibers. **Moreover, you continue to split tongues, then pilot drilling and hand nailing may be your only option.**

Fastener gauge Lengths: When installing solid wood flooring, make sure the fastener length is no longer, than 1½" for installations over ¾" sub floors attached to the surface of a concrete slab. However, for installations over raised foundations the recommend fastener length is 1 ¾".

Fastener Schedule: Typical fastening schedule is 1" to 3" from the board ends and 6" to 8" there after. **Failure to follow required fastening schedule can result in squeaky board/floor syndrome.**

NOTE: Some wood species i.e. Tiger wood, Lapacho, Patagonian Rosewood etc., may require pilot drilling and hand nailing in order to prevent splitting of the tongue and or telegraphing fasteners. JOHNSON HARDWOOD WILL NOT WARRANTY AGAINST SAID CONDITIONS.

Disclaimer of Non-Responsibility:

Statement/disclaimer of non responsibility (voids any/all applicable warranties offered by Johnson) pertaining to labor/material costs and or damages caused to any/all cabinets, furniture, counter tops, built-in ranges/stoves, moldings/trims, fixed furniture/wall units, wall paper, painting, specialized plaster coatings, etc., as a result of removal of the flooring, cupping, buckling, twisting, bowing, shrinking, lifting, moving etc. Johnson reserves the right to void any/all warranties if and when any of the above mentioned or non mentioned item(s) are installed over the surface of a Johnson Hardwood floor where the floor experiences a manufacturer or non manufacturer related failure, which requires the removal of the flooring in part, or in its entirety. Johnson Hardwood wood flooring products **MUST NOT** be installed (under cabinets, etc.) prior to the installation of cabinetry and or any other fixed furniture etc., as outlined above. The general contractor/flooring contractor/designer/homeowner/renter etc., assume **ALL** responsibility for any/all damages/costs incurred if flooring is laid prior to the installation of the above mentioned or non mentioned items. Said parties absolve Johnson Hardwood from any/all liability/responsibility of any claims now or in the future.

WARNING: DO NOT INSTALL MOLDINGS/TRIMS IF THERE IS ANY QUESTION TO THERE ACCEPTABILITY. INSTALLATION CONSTITUTES ACCEPTANCE OF THE MATERIAL BEING INSTALLED!

Johnson Hardwood **WILL NOT** be responsible/liable for any/all costs (i.e. **LABOR**) associated with any/all claims involving **color difference** issues within/the wood floor and any/all supporting trim components (e.g. stair treads, stair nosing's, reducers, T-moldings, end caps etc.), after the molding/trims have been installed. It is the responsibility of the flooring contractor/installer/dealer to make certain that the moldings color blend to the flooring is acceptable before installing it/them.

Precautionary Statement: Before mixing materials, (i.e., Wood flooring from different runs/lots) MAKE SURE the color tone is acceptable before installing the floor. IT IS THE RESPONSIBILITY OF THE DESIGNER, ARCHITECT, BUILDER, HOMEOWNER, OR FLOORING CONTRACTOR ETC., TO DISCUSS WITH THE FLOORING INSTALLER(S) THE ACCEPTABLE COLOR TONE RANGE OF THE FLOORING BEING INSTALLED. THE APPROVED FLOORING SAMPLE MUST BE SHOWN TO THE INSTALLER(S) BEFORE COMMENCING WITH THE INSTALLATION. MOREOVER, THE APPROVED COLOR TONE SAMPLE MUST BE USED/VIEWED AS A GO-NO-GO TOOL. ONCE INSTALLED, THERE IS NO QUESTION AS TO THE FLOORS ACCEPTABILITY. INSTALLATION CONSTITUTES ACCEPTABILITY OF THE MATERIAL BEING INSTALLED. JOHNSON HARDWOOD WILL NOT BE RESPONSIBLE FOR ANY/ALL COSTS (I.E. MATERIALS AND/OR LABOR) ASSOCIATED WITH CLAIMS INVOLVING COLOR TONE RELATED ISSUES.