



Quality Floors From Start to Finish:

Choosing and Preparing
Wood Subfloors for Finish Floorings



By Robert Kuserk, PE

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

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Webinar Attendee Survey



Robert Kuserk, PE



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Training Objectives

Objectives

- Understand APA products and how they relate to the installation of various finish flooring systems
- Understand building tolerances for the different finish flooring systems
- Learn how moisture affects different finish flooring systems
- Understand the importance of conditioning materials when installing various finish flooring systems

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Agenda

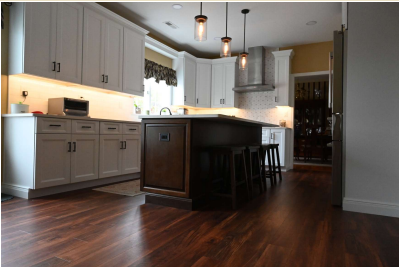
- Terms and Definitions
- Moisture Effects on Wood Structural Panels
 - Drying and shrinkage in floor systems
 - Measurement of moisture content
- Preparation of Subfloor for Finish Flooring
 - Framing details to avoid
 - Fastener performance
 - Acclimation
- Tile Assemblies

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What's the Problem?

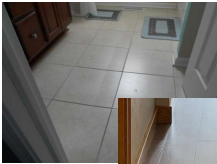


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What's the Problem?



Cracked Tile



Telegraphing



Gaps



Cupping

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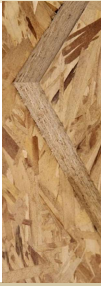


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Definitions



Plywood v. OSB
Veneers v. Strands
PS-1 Prescriptive or PS-2 Performance Standard
Both OSB and Plywood
Alternating Layer Direction
Moisture-Resistant Adhesive
Wet and Dry Structural Performance Tests
Available in Exposure 1 and Exterior Bond Classifications



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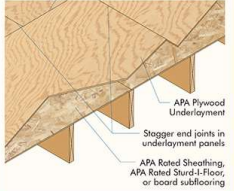


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Definitions – Under the floor

- Subfloor – Rated Sheathing or Sturd-I-Floor
- Underlayment
- Sturd-I-Floor

FIGURE 1
APA PLYWOOD UNDERLAYMENT



Provide 1/32" space between underlayment butt joints

APA Plywood Underlayment

Stagger end joints in underlayment panels

APA Rated Sheathing, APA Rated Sturd-I-Floor, or board subflooring

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Definitions – Flooring Types

▪ Wood Flooring

▪ Solid Wood Flooring

▪ Engineered Wood

▪ Composite Engineered Wood



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Definitions – Flooring Types

▪ Vinyl Flooring

▪ Standard, Sheet or Solid Vinyl Tile

▪ Luxury Vinyl Plank (LVP)

▪ Luxury Vinyl Tile (LVT)



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Definitions – Flooring Types

▪ Tile

▪ Ceramic

▪ Stone

▪ Carpet and Pad

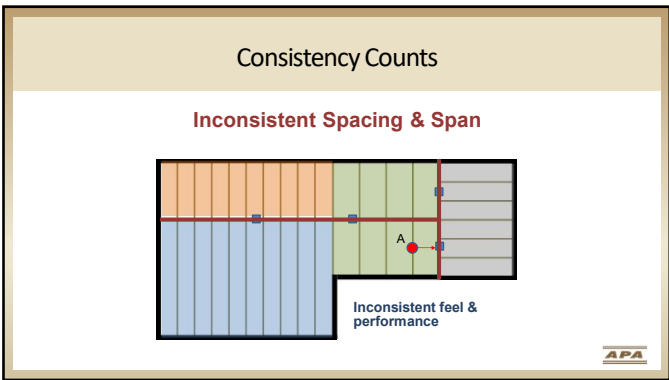


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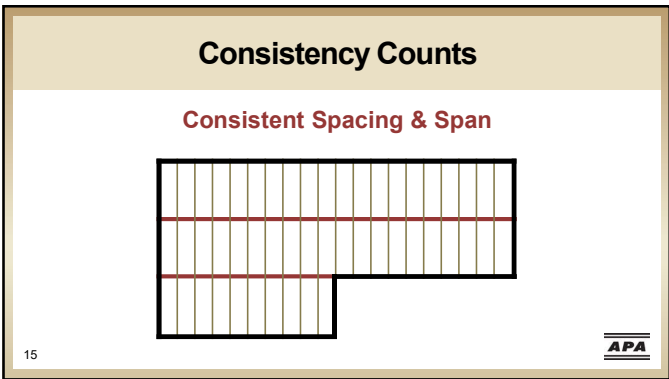
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Minimum Subfloor Sizes

APA Performance Subfloors under

TABLE 1

SUBFLOORS AND SPACING OF FLOOR FRAMING FOR HARDWOOD FLOORING^(a)

Floor Framing Spacing (in.)	Wood Structural Panels, Such as Plywood and OSB	
	Minimum Performance Category	Minimum Span Rating
16	19/32	40/20 or 20 oc
19.2	23/32	48/24 or 24 oc
24 ^(b)	7/8	60/32 or 32 oc

(a) Thicker panels with a higher Span Rating may be used.
(b) Alternatively, National Wood Flooring Association (NWFA) recommends a 2-layer subfloor consisting of 23/32 Performance Category 48/24 Rated Sheathing or 24 oc Rated Sturd-I-Floor plus 15/32 Performance Category 32/16 wood structural panel offset half panel in each direction.

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Continuous Bead

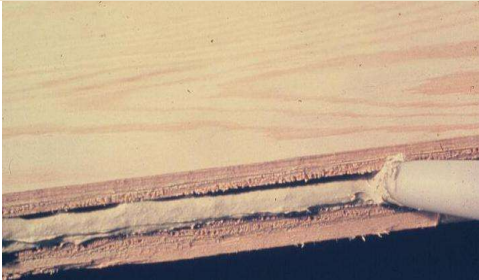


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Glue the T&G Joint



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Panel Spacing

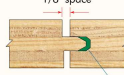
BUILDER TIP

Construct a Solid, Squeak-Free Floor System

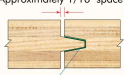


EXAMPLES OF TONGUE-AND-GROOVE (T&G) JOINTS*

1/8" space



Approximately 1/16" space



In Glued Floor Systems, use adhesives conforming with ASTM D3498 or AFG-01.

* T&G profiles and installation recommendations can vary among APA members. Check with individual manufacturer for specific recommendations – otherwise, APA recommends 1/8" spacing at time of installation for all panel edges.

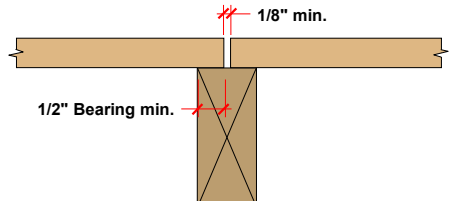
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Wood Moves

- Panels spaced 1/8 inch at installation



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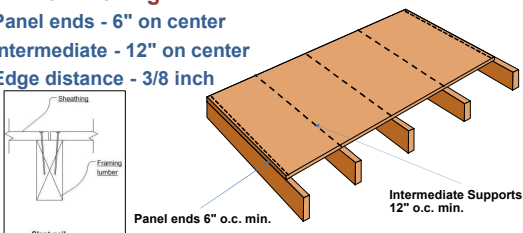


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Minimum Sheathing Fastening Recommendation

Minimum Nailing

- Panel ends - 6" on center
- Intermediate - 12" on center
- Edge distance - 3/8 inch



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Minimum Underlayment Fastening Recommendation

- Minimum Nailing for Underlayment
 - Minimum 1/4 Performance Category
 - 3d x 1-1/4" ring- or screw-shank nails
 - Panel ends - 3" on center
 - Intermediate - 6" each way
 - Edge distance - 3/8 inch
 - Minimum 11/32 Performance Category
 - 3d x 1-1/4" ring- or screw-shank nails
 - 4d x 1-1/2" ring- or screw-shank nails for Performance Category 19/32 to 3/4
 - Panel ends - 6" on center
 - Intermediate - 8" each way
 - Edge distance - 3/8 inch

FIGURE 1
INSTALLATION OF APA PLYWOOD UNDERLAYMENT

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Minimum Fastening for Floors, Walls & Roofs

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Floor Flatness Criteria

- National Wood Flooring Association (NWFA)
 - Mechanical Fasteners greater than 1 1/2"
 - 3/16" in 6' or 1/4" in 10'
 - Glued, Floating, Mechanical Fasteners less than 1-1/2"
 - 1/8" in 6' or 3/16" in 10'
- Manufacturer Recommendations
 - 1/8" in 6' or 3/16" in 10'

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How flat is your floor?

- **North American Laminate Flooring Association (NALFA)**
 - The subfloor surface must be flat. Flat means no low spots or ridges in excess of allowances in the manufacturer's instructions.
 - 3/8" on a 6' radius
- **Manufacturer Recommendations**
 - 1/32" in 1' and 3/16" in 10'
 - 1/8" in 6'
 - 1/16" in 1' or 3/16" in 10'



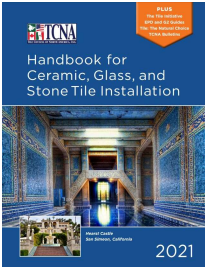
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How flat is your floor?

- **Tile Council of North America (TCNA)**
 - 1/4 inch in 10 feet for tiles with edges shorter than 15 inches
 - 1/8 inch in 10 feet for tiles with at least one edge greater than 15 inches



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Panel Ridging



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Framing Alignment

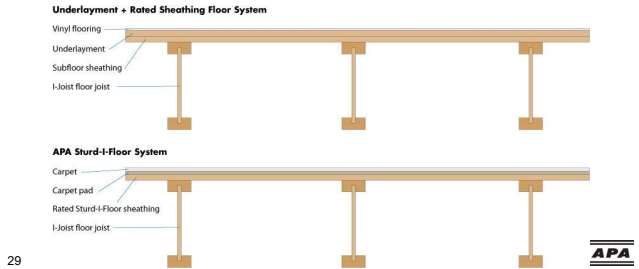


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Subfloor Systems



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Underlayment

TABLE 2
TYPICAL PANEL FLOOR SPECIFICATIONS BASED ON FINISH FLOOR INSTALLATIONS
(All must meet minimum structural requirements⁽¹⁾ of IBC or IRC)

Finish Floor	Subfloor Construction ⁽²⁾	Example Subfloor Specification ⁽²⁾	Typical Underlayment Panel
Carpet and Pad	Single Layer Construction		
	APA Rated Sturd-I-Floor ⁽³⁾ with T&G edges	APA Sturd-I-Floor 24 oc Exposure 1 T&G (for joists spaced 24 inches o.c. or less)	NA
	Double Layer Construction		
	APA Rated Sturd-I-Floor or APA Rated Sheathing	APA Rated Sheathing 48/24 Exposure 1 (for joists spaced 24 inches o.c. or less)	Any Table 1 panel

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Underlayment

TABLE 2

TYPICAL PANEL FLOOR SPECIFICATIONS BASED ON FINISH FLOOR INSTALLATIONS
(All must meet minimum structural requirements⁽¹⁾ of IBC or IRC)

Finish Floor	Subfloor Construction ⁽²⁾	Example Subfloor Specification ⁽²⁾	Typical Underlayment Panel
Hardwood Flooring	APA Rated Sturd-I-Floor or APA Rated Sheathing	APA Rated Sturd-I-Floor 24 oc Exposure 1 T&G or APA Rated Sheathing 48/24 Exposure 1 (for joists spaced 19.2 inches o.c. or less) ⁽⁴⁾	(Optional)
Vinyl (or other thin resilient floor covering) or Glue-down Carpet	APA Rated Sturd-I-Floor ⁽³⁾ or APA Rated Sheathing	APA Rated Sturd-I-Floor 24 oc Exposure 1 T&G or APA Rated Sheathing 48/24 Exposure 1 (for joists spaced 24 inches o.c. or less)	Any Table 1 panel ⁽⁶⁾

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Underlayment

TABLE 2

TYPICAL PANEL FLOOR SPECIFICATIONS BASED ON FINISH FLOOR INSTALLATIONS
(All must meet minimum structural requirements⁽¹⁾ of IBC or IRC)

Finish Floor	Subfloor Construction ⁽²⁾	Example Subfloor Specification ⁽²⁾	Typical Underlayment Panel
Ceramic Tile ⁽⁷⁾	Minimum Performance Category 19/32 APA Rated Sturd-I-Floor Exposure 1 or APA Rated Sheathing Exposure 1	Minimum Performance Category 19/32 APA Rated Sturd-I-Floor Exposure 1 or APA Rated Sheathing Exposure 1 (for joists spaced 16 inches o.c. or less) ⁽⁸⁾	Minimum Performance Category 19/32 APA Rated Sturd-I-Floor Exposure 1 or APA Rated Sheathing Exposure 1 ⁽⁶⁾

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Underlayment

TABLE 1

RECOMMENDED PLYWOOD GRADES FOR UNDERLAYMENT⁽¹⁾ APPLICATIONS

Grade ⁽¹⁾⁽²⁾	Exposure Durability Classification	Look for These Special Notations in Panel Trademarks ⁽³⁾	Typical Trademarks	Grade ⁽¹⁾⁽²⁾	Exposure Durability Classification	Look for These Special Notations in Panel Trademarks ⁽³⁾	Typical Trademarks
APA Underlayment ⁽⁴⁾	Exposure 1 or Exterior	Sanded Face ⁽⁵⁾		APA A-C Underlayment APA B-C Underlayment	Exterior		
APA C-C Plugged APA Underlayment C-C Plugged	Exterior	Sanded Face ⁽⁵⁾		APA Rated Sturd-I-Floor ⁽⁶⁾	Exposure 1 or Exterior	Sanded Face ⁽⁵⁾	
APA A-C APA B-C APA A-D APA B-D	Exterior Exterior Exposure 1 Exposure 1	Plugged Crossbands Under Face ⁽⁷⁾		APA Marine Grade	Exterior	[MARINE-A-A, EXT-C, 300 B, *N-A, 300-PS, 150-SB, 150-CAT]	

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Underlayment?

TABLE 3
APA UNDERLAYMENT FASTENING RECOMMENDATIONS

Application	Minimum Performance Category	Fastener Size and Type ⁽¹⁾	Maximum Fastener Spacing (in.) ⁽²⁾	
			Panel Edges ⁽³⁾	Intermediate
Over smooth subfloor	1/4	3d x 1-1/4-in. ring- or screw-shank nails min. 12-1/2 gage	3	6 each way
Over lumber subfloor or uneven surfaces	11/32	(0.099 in.) shank dia. ⁽⁴⁾	6	8 each way

(1) See APA Engineered Wood Construction Guide, Form E30, for nail dimensions.
(2) Fasteners for 5-ply plywood underlayment panels and for panels with a Performance Category greater than 1/2 may be spaced 6 inches on center at edges and 12 inches each way intermediate.
(3) Fasten panels 3/8" from panel edges.
(4) Use 4d x 1-1/2" ring- or screw-shank nails, minimum 12-1/2 gage (0.099") shank diameter, for underlayment panels with a Performance Category of 19/32 to 3/4.

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Underlayment?

Joist Spacing	Minimum Subfloor Performance Category	Minimum Span Rating
≤ 16"	19/32 plywood or 23/32 OSB	40/20 or 20 oc
> 16" and ≤ 19.2"	23/32 plywood or OSB	48/24 or 24 oc
> 19.2" and ≤ 24"	7/8 plywood or OSB	60/32 or 32 oc

WOOD FLOORING INSTALLATION GUIDELINES

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nwfa
National Wood Flooring Association

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Luxury Vinyl Underlayment

- **Wood Subfloor**
 - Must meet local building codes, be structurally sound and deflection free
 - Repair squeaks
 - Sand or plane high spots
 - Fill low spots
 - Manufacturers' recommendations always supersede the recommendations in this publication

NALFA
NORTH AMERICAN LAMINATE FLOORING ASSOCIATION

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Luxury Vinyl Underlayment

▪ **Manufacturer “A” Recommendations**

▪ If the surface of the wood subfloor is not smooth, a 1/4” underlayment panel should be installed over the subfloor. Any panels selected as an underlayment must meet the following criteria.

▪ Be dimensionally stable

▪ Have a smooth, full-sanded face so the graining or texturing will not show through

▪ Be resistant to both static and impact indentation

▪ Be free of any surface components that may cause staining such as plastic fillers, marking inks, sealers, etc.

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Luxury Vinyl Underlayment

▪ **Manufacturer “B” Recommendations**

▪ **Acceptable Subfloor Types:**

▪ OSB – At least 3/4” thick, PS-2-92 rated or PS-1-95 rated.

▪ Underlayment Grade Particleboard (Minimum 40 lb. Density) – Glue down/floating floors only

▪ CDX Plywood – At least 5/8” thick for joist spacing up to 16” on center, minimum 3/4” thick for joist spacing greater than 16” on center (19.2” maximum). Plywood subfloors installed over concrete must be installed in accordance with the guidelines set forth by the National Wood Flooring Association.

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Luxury Vinyl Underlayment

▪ **Manufacturer “C” Recommendations**

▪ **C. Wood Subfloors**

▪ Resilient floors are recommended on suspended (or raised with a minimum 18” well-ventilated air space below) subfloors with a 1/4” underlayment

▪ Loading requirements for subfloors are normally set by various building codes

– Note: When installing directly over wood subfloors, the moisture content of the subfloor should be less than 13%.

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Luxury Vinyl Underlayment

- **Manufacturer “C” Recommendations (Cont'd)**
 - **Wood Subfloors**
 - **1. APA Rated STURD-I-Floor**
 - Panel can be manufactured as conventional plywood, as a composite or as oriented strand board.
 - Single-layer wood subfloor increases the potential for staining from panel components, coated nails, construction adhesives, spills, overspray and show-through from the texture and mechanical or water damage when resilient floors are installed directly to single-layer STURD-I-Floor.

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Luxury Vinyl Underlayment

- **Manufacturer “C” Recommendations (Cont'd)**
 - **Wood or Board-Type Underlayment**
 - **Plywood**
 - APA trademarked plywood or equivalent agency certified plywood rated as suitable underlayment for resilient floor coverings such as tile or sheet vinyl. It should have an Exterior or Exposure 1 exposure durability classification and a fully sanded face. APA plywood underlayment grades recommended for areas to be covered with resilient non-textile flooring are A-C, B-C, C-C Plugged, or C-C Plugged EXT when marked “sanded face.”

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Ceramic Tile Underlayment



TECHNICAL TOPICS
Ceramic Tile Over Wood Structural Panel Floors

When installing a resilient floor over a wood structural panel floor, the underlayment must be installed over a smooth, flat, and clean surface. The underlayment must be installed over a surface that is free of any protrusions, voids, or other defects that could affect the performance of the resilient floor. The underlayment must be installed over a surface that is free of any moisture or other contaminants that could affect the performance of the resilient floor. The underlayment must be installed over a surface that is free of any other materials that could affect the performance of the resilient floor.

TCNA No.	Service Classification**	Max. Joint Spacing (in. m.c.)	Underlayment Layer	Subfloor Layer	Comment
F141	Light Commercial	16	Marble bed (1-1/2" minimum, 2" maximum)	19/32" Exposure 1 T&G plywood	---
F142	Residential	16	Exposure 1 plywood	19/32" Exposure 1 T&G plywood	---
F143	Residential or Light Commercial	16	Light commercial Exposure 1 plywood	19/32" Exposure 1 T&G plywood	15/32" plywood underlayment layer gives "Residential" performance
F144	Residential or Light Commercial	16	Commercial boiler units or fiber cement underlayment	23/32" Exposure 1 T&G plywood	19/32" plywood subfloor gives "Residential" performance
F145	Light Commercial	16	3/8" Minimum to 1-1/2" maximum marble bed	23/32" Exposure 1 T&G plywood	Change membrane plus metal lath
F146	Light Commercial	16	Coned glass-mat boiler board	19/32" Exposure 1 T&G plywood	---
F147	Residential	24"	Exposure 1 plywood plus uncoupling membrane	23/32" Exposure 1 T&G plywood	4" x 4" or larger tile only

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Source of Moisture in Subfloors



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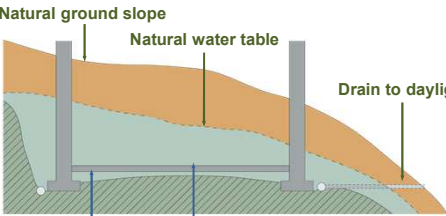
Direct Wetting

Ambient

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Water Table Slope



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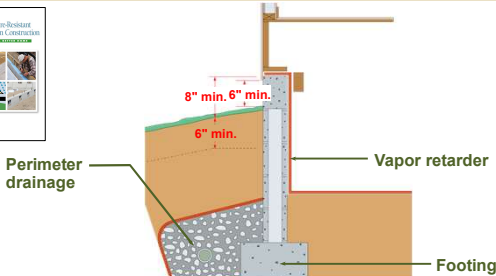
Water table lowered by foundation drains

Water table rises at center of building

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Concrete Masonry Crawl Space Foundation



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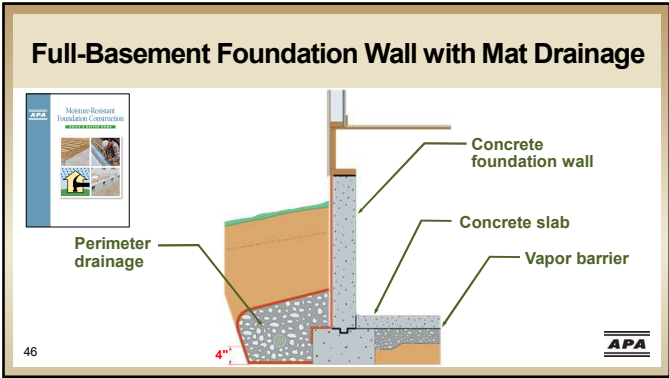
Perimeter drainage

Vapor retarder

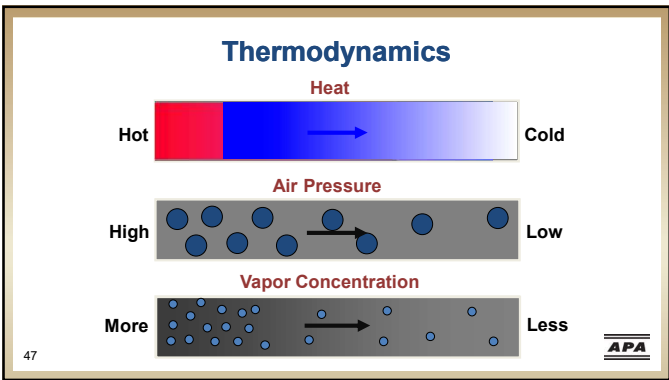
Footing

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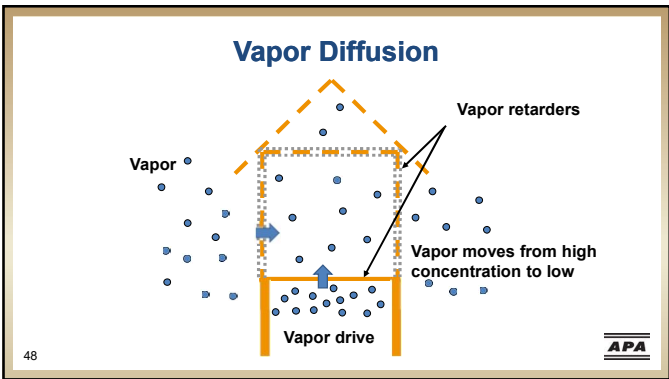
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CAUTION

Finish Flooring Problem Scenario

Installation

MC = 2-6%

Subfloor

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CAUTION

Finish Flooring Problem Scenario

After heavy rain

MC = 30%

Subfloor expands

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CAUTION

Finish Flooring Problem Scenario

Dried-in
HVAC inactive

MC = 25%

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CAUTION

Finish Flooring Problem Scenario

Finished Floor Installed

▪ Wood flooring attached

▪ HVAC still inactive

MCv = 6–14%

MC = 20%–25%

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CAUTION

Finish Flooring Problem Scenario

Finished Floor In-place

Cupping

Compression

MC = 16%

MC = 18%

Fasteners

Subfloor shrinks

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CAUTION

Finish Flooring Problem Scenario

Space Conditioned

▪ HVAC activated

Reduced cupping

Joints begin to open

MC = 14%

MC = 16%

Fasteners loosen

Subfloor still shrinking

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CAUTION

Finish
Flooring
Problem
Scenario

Flooring Sanded and Finished

Floor—Cup or crown?

MC = 12%

MC = 12%

Joints open

Fastener noises

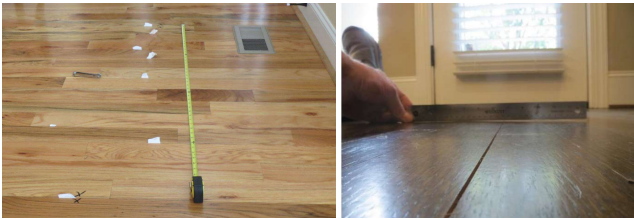
- Flooring fasteners
- Subfloor fasteners

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Shrinkage of Flooring



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Expansion of Flooring



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Shrinkage of Flooring

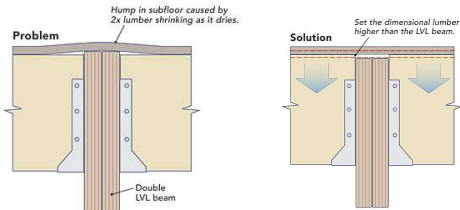


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Framing Shrinkage



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Floor Shrinkage

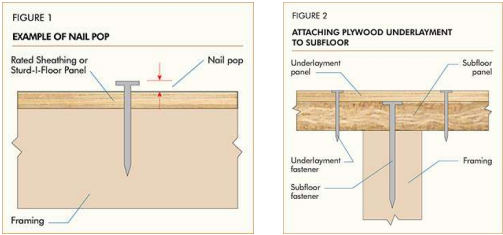


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Nail Pops



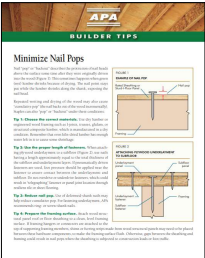
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Fasteners

- Minimize Nail Pops
 - Choose the correct materials
 - Use the proper length of fasteners
 - Use ring- or screw- shanks nails
 - Prepare the framing surface



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Avoiding Moisture Problems



Conditioning Homes
A recipe for eliminating interior callbacks

There is a story that begins with bathroom flooding, but it is not about the water damage, building time, and the subsequent cost of the repairs. It is about the importance of conditioning homes before occupancy. The story is about the importance of conditioning homes before occupancy. The story is about the importance of conditioning homes before occupancy.

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Drying of Subfloor



FansDehumidification

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Drying of Subfloor



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Drying of Subfloor



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Acclimatization

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BUILDER TIPS

Proper Handling and Installation of APA Plywood Underlayment



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Moisture

- **Are we ready to install?**
 - Moisture can affect a finished floor
 - Dry
 - Similar Moisture Content
 - What is dry?
 - When is it dry enough?
 - What are the recommendations?



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Moisture

- **Solid Wood Flooring—NWFA**
 - MC of the subfloor should align with the required conditions in the facility
 - MC of the wood subfloor no more than 4% greater than the MC of solid strip, < 3" widths, and 2% ≥ 3" widths.
- **Manufacturer Specification**
 - Wood subflooring materials must not exceed 12% moisture content. 4% for strips < 3" and 2% for strips ≥ 3".
- **NALFA**
 - Determine what the expected seasonal changes of moisture content are for your geographical location.

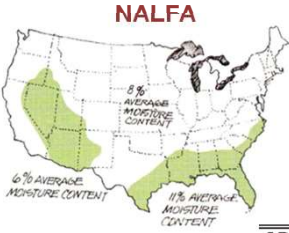
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Moisture

- Most areas of the US average 8% EMC, ranging from 6–10% EMC
- Dry Southwest average—6% EMC, ranging from 4–9% EMC
- Damp, Warm, Coast average 11% EMC, ranging from 8–13%



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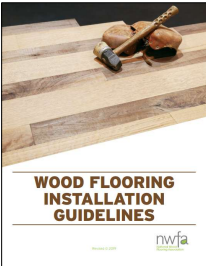
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Moisture

- Hardwood floor is delivered dry or less than 10% MC
- Upon delivery, take MC on 40 boards up to 1,000 sq. ft. and 4 readings per 100 sq. ft. after the initial readings.
- Check MC of the subfloor at 20 locations for the first 1000 sq. ft. and 4 readings per 100 sq. ft. after the initial readings.

www.nwfa.org

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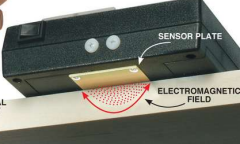


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Measuring Moisture



Resistance type meters



Capacitance type meters

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Final Steps

- Structure is fully enclosed
- HVAC systems are operational
- Upon delivery of flooring
 - Initial flooring moisture readings
 - Initial subfloor moisture readings
- Ensure moisture contents meet recommendations prior to installation

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Recap

- Terms and Definitions
- Moisture Effects on Wood Structural Panels
 - Drying and shrinkage in floor systems
 - Measurement of moisture content
- Preparation of Subfloor for Finish Flooring
 - Framing details to avoid
 - Fastener performance
 - Acclimatization
- Tile Assemblies

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Recap

Main Takeaways

- Floor flatness
- Moisture
- Follow the details, use the right products

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