chapter 15. FINISHES

15.1 PERFORMANCE CONSIDERATIONS

15.1.1 GENERAL

Finishes applied to buildings have a dual function. They are expected to be aesthetically satisfactory, and they are also expected to protect the underlying material from degrading influences, primarily light and moisture. Maintenance must be considered in choosing a finish. The range of choices may mean that reapplications will be required as soon as in one year or as late as seven to ten years, so the choices are important. Another important consideration is the ease of preparing the weathered surface for reapplication.

Other design choices also significantly affect finish performance. Most important are the choice of wood species, grade for lumber or plywood, characteristics of other wood products and the details of installation. Particularly important is the amount of roof overhang relative to the height of the wall. The Swiss suggest that a ratio of 1:8 yields substantially reduced maintenance requirements; the few discussions found in United States literature simply emphasize the importance of the concept.

Finishing systems can be grouped into those that provide some sort of "natural" effect and those that do not. Varnishes, penetrating oils, water-repellent preservatives, and weathering without a finish are the primary examples of the former group; paints and opaque heavy-bodied stains are the principal types in the latter. The semi-transparent stains are intermediate, generally allowing the wood grain and texture to show through the finish, but masking the natural wood color. Varnishes and other similar transparent film-forming systems require extensive maintenance and are not considered suitable for exterior wood surfaces except under very special and limited circumstances.

Weathering without a finish application results in a nonuniform appearance after a brief initial period; but if that appearance is satisfactory, maintenance requirements can be exceedingly low with the right siding choice. Periodic applications of a water repellent provide a relatively easy modification that makes the appearance more uniform over time and increases acceptability for many individuals. This method is best suited to sawn lumber of species with the best weathering characteristics--redwood and the cedars. It is less satisfactory with lumber of other species. It is not satisfactory as the finishing system for any type of plywood or other composite wood product used in exterior applications.

Good-quality paints properly applied provide the longest service life. The opaque stains are generally similar to paints, but with a lower pigment concentration to allow textures to show through. They perform similarly to paints but require more frequent maintenance. Semitransparent stains provide much less protection from both moisture and light, and must be reapplied more frequently than the paints and heavier stains. However, surface preparation and reapplication are generally low (see **Tables 15-1** and **15-2**).

Both finish type and wood species affect performance. Ability to exclude moisture results in reduced cyclic shrinkage and swelling stresses in the siding and at the wood finish interface. Conversely, the ability to transmit moisture will minimize peeling and blistering of the films. These opposing but desirable properties must be balanced when considering siding characteristics and expected exposure conditions. **Table 15-1** lists finish systems according to various performance considerations. **Table 15-2** provides information on how some finish systems perform with different siding materials species. **Table 15-3** provides information on the ability of systems to retard the movement of moisture; **Table 15-4** rates different woods in general on several characteristics important for use as exterior siding.

15.1.2 Paint

When paint is applied to wood, it forms a surface film that does not penetrate significantly into the wood. This film protects the wood from weathering and moisture-related degradation. The most common types of paint are latex based and oil based. Latex paint is generally easier to use, and allows relatively free moisture movement (see **Table 15-3**).

Proper preparation is essential for the longevity of the paint. The surface must be free from dirt, oil, and other foreign substances. The wood surface should be painted as soon as possible after installation. Within a relatively short period of time (four to six weeks), unpainted exposed wood suffers enough surface degradation to dramatically reduce finish adhesion. Wood siding and trim should be treated with a water repellent before finishing. Water repellents retard swelling and shrinking. Lap and butt joint areas of panel products are especially vulnerable and should be well treated.

For optimum performance, the coats of paint of appropriate thickness should be applied over the primer. Total thickness of primer plus two coats of paint should be from four mils to six mils thick. Quality paints applied in this manner can last up to ten years depending on the environmental exposure, at least two to three times as long as the typical two-coat job. Painted surfaces may require extensive surface preparation prior to repainting.

15.1.3 Solid-Color Stain

Solid-color stains or heavy-body stains are opaque and contain higher concentrations of pigment than semitransparent stains. They form a surface film like paints, although

not as thick, if applied as recommended by the manufacturer. They are also available in latex-based or oil-based formulations. Latex stains are generally considered more durable. Surface preparation for refinishing is generally much less than required for painted surfaces.

Solid-color stains are best applied by brush. One coat of stain is often used, but two coats are better. Because this stain is thinner than paint, lap marks may form, especially with the faster-drying latex stain. To prevent lap marks, only a small area should be stained at one time. Avoid application in intense sunlight.

15.1.4 Semitransparent Stain

Semitransparent stains are lightly pigmented and are intended to be at least partially absorbed into the wood. For long life, two coats should be used. Generally, the second coat should be applied 20 minutes after the first coat and before it has dried. A two-coat application is especially important on panel plywood product because the semitransparent stain is not as protective as the solid-color stain or paint.

15.1.5 Water Repellent

Water repellents consist of a small amount of wax and resins dissolved in a solvent. They are often mixed with a fungicide and used as a water-repellent preservative. The water repellent keeps rain or dew from penetrating the wood, especially at joints and end grain. This prevents swelling and protects the wood from high-moisture conditions that promote decay. The fungicide inhibits surface decay or mildew.

The most effective method of application is to dip the member into the water-repellent solution. Brush application can be effective but is highly variable. When wood is treated after installation, a liberal amount of solution should be applied at vulnerable areas like butt joints, lap joints, corners, and door and window trim.

15.1.6 Varnish

Transparent film-forming finishes such as varnishes provide an attractive finish for wood. However, most of these products should not be used on wood exposed to sunlight. Regardless of product quality, thicknesses of film, or whether ultraviolet absorbers are used, the film will deteriorate after a limited time, sometimes within one year. At this time, light degradation of the wood surface beneath the finish is unavoidable as discussed in Chapters 2 and 3. Reapplication usually requires that the old finish be completely removed.

15.2 DESIGN CONSIDERATIONS

15.2.1 Finish Surface

Wood sidings are subject to shrinkage and swelling due to their hygroscopic nature and the normal changes of air humidity. Dimensional stability is generally better for wood of lighter density and woods containing large amounts of extractives. Redwood and cedar, for example, are very

good for a painted finish. The grain pattern also affects how the wood will hold paint. Species with wide bands of late wood, such as southern yellow pine and some Douglas-fir, will not hold paint well, and penetrating stains are preferred. Annual ring orientation on wood siding also affects the finish-holding capacity. Vertical grain siding will hold much better than flat-grain material: the dense late wood bands are limited in exposed width.

Plywood panel sidings do not shrink and swell as much as lumber siding, because movement in each ply is restrained by adjacent cross plies. However, plywood will progressively develop surface checks through cyclic exposure to moisture and sunlight. These checks can lead to early paint failure, especially with oil-based paint. On plywood, satex paints tend to perform better than oil based. When a painted finish is desired, medium-density overlay plywood is recommended. In this type of panel, the surface checks and imperfections are sealed, with the overlay providing a good surface to hold paints. For rough-sawn or textured plywood panels, stains are more satisfactory.

15.2.2 Vapor Retarders

In colder climates, finish performance may be affected by moisture migration through the sidewall. Water vapor from inside the house may condense in the wall during the winter if a vapor barrier is not present. When warm weather returns, moisture in the siding can cause the finish film to blister, especially films like the oil-based paint that limit moisture movement. The best way to alleviate this problem is to prevent moisture condensation in the wall by proper use of a vapor retarding film.

Table 15-1.
Summary of Alternative Systems Used for Exterior Wood Finishing[1]

Finish	Application Method	Appearance of Wood	Relative Cost of Initial Treatment	Maintenance Procedure	Maintenance period of Surface Finish	Relative Maintenance Cost
Clear varnish	Three coats (minimum)	Grain and natural color unchanged if adequately maintained	High	Clean and stain bleach areas; apply two more coats	2 years or when breakdown begins	High
Paint	Water repellent, prime, and two topcoats	Grain and natural color obscured	Medium to high	Clean and apply topcoat, or remove and repeat initial treatment if damaged	7-10 years[2]	Medium
Organic solvent preservatives[3]	One coat, dipping, brushing	Grain visible; colored as desired	Low to medium	Brush down and reapply	2-3 years or when preferred	Medium
Solid-color stains	Water repellent and two topcoats	Grain and natural color obscured; surface texture retained	Medium	Clean and apply topcoat, or remove and repeat initial treatment if damaged	4-6 years	Medium
Semi-transparent stains	One or two brush coats	Grain visible; color as desired	Low to medium	Clean and apply sufficient finish	3-6 years or when preferred	Low to medium
Water repellent[4]	One or two brush coats of clear material or, preferably, dip applied	Grain and natural color visible, becoming darker and rougher textured	Low	Clean and apply sufficient finish	1-3 years or when preferred	Low to medium
No finish[5]		Highly variable, from bleached driftwood to very dark, often on same wall; rustic	None	Nothing, or cleaning with detergent and water	When preferred	Low to none

[1]This table is a compilation of data from the observation of many researchers and from major sections of Agricultural Handbook No. 647, USDA.
[2]Using top-quality acrylic latex topcoats.
[3]Pentachlorophenol, bis(tri-n-butyltin oxide), copper naphthenate, copper-8-quinolinolate, and similar materials.
[4]With or without added preservatives. Addition of preservative helps control mildew growth.
[5]Generally limited to board sidings of redwood or the cedars.

Table 15-2.
Suitability of Different Finishing Methods for Exterior Wood Surfaces[1]

Stains	Water-Repellent Preservative		Semitransparent Stain		Paints and Solid Color	
Type of Exterior Wood Surfaces	Suitability	Expected Life[2] (yrs)	Suitability	Expected Life[3] (yrs)	Suitability	Expected Life[4] (yrs)
SIDING:						
Cedar and Redwood						
Smooth (vertical grain)	High	1-2	Moderate	2-4	High	4-6
Roughsawn or weathered	High	2-3	Excellent	5-8	Moderate	3-5
Pine, fir, spruce, etc.						
Smooth (flat-grained)	High	1-2	Low	2-3	Moderate	3-5
Rough (flat-grained)	High	2-3	High	4-7	Moderate	3-5
Shingles						
Sawn	High	2-3	Excellent	4-8	Moderate	3-5
Split	High	1-2	Excellent	4-8	—	—
Plywood (Douglas-fir and southern pine)						
Sanded	Low	1-2	Moderate	2-4	Moderate	3-5
Textured (smooth)	Low	1-2	Moderate	2-4	Moderate	3-5
Textured (roughsawn)	Low	2-3	High	4-8	Moderate	4-6
Medium-density overlay[5]	—	—	—	—	Excellent	6-8
Plywood (cedar and redwood)						
Sanded	Low	1-2	Moderate	2-4	Moderate	3-5
Textured (smooth)	Low	1-2	Moderate	2-4	Moderate	3-5
Textured (roughsawn)	Low	2-3	Excellent	5-8	Moderate	4-6
Hardboard, medium density[6]						
Smooth						
Unfinished	—	—	—	—	High	4-6
Preprimed	—	—	—	—	High	4-6
Textured						
Unfinished	—	—	—	—	High	4-6
Preprimed	—	—	—	—	High	4-6
Millwork (usually pine)						
Windows, shutters, doors, exterior trim	High[7]	—	Moderate	2-3	High	3-6
Decking						
New (smooth)	High	1-2	Moderate	2-3	Low	2-3
Weathered (rough)	High	2-3	High	3-6	Low	2-3
Glue-laminated members						
Smooth	High	1-2	Moderate	3-4	Moderate	3-4
Rough	High	2-3	High	6-8	Moderate	3-4
Waferboard	—	—	Low	1-3	Moderate	2-4

[1]These data were compiled from the observations of many researchers. Expected life predictions are for an average location in the continental United States; expected life will vary in extreme climates or exposure (desert, seashore, deep woods, etc.). From Agricultural Handbook No. 647, USDA.

[2]Development of mildew on the surface indicates a need for refinishing.

[3]Smooth, unweathered surfaces are generally finished with only one coat of stain, but roughsawn or weathered surfaces being more adsorptive can be finished with two coats, with the second coat applied while the first coat is still wet.

[4]Expected life of two coats, one primer and one topcoat. Applying a second topcoat (three-coat job) will approximately double the life. Top-quality acrylic latex paints will have the best durability.

[5]Medium-density overlay is generally painted.

[6]Semitransparent stains are not suitable for hardboard. Solid color stains (acrylic latex) will perform like paints. Paints are preferred.

[7]Exterior millwork, such as windows, should be factory treated according to Industry Standard IS4-81. Other trim should be liberally treated by brushing before painting. Treatment to be followed by application of stain or paint.

Table 15-3.
Moisture-Excluding Effectiveness of Three Coats of Various Finish Systems[1]

Effective[2]		Somewhat Effective		Ineffective	
%	Finish Type	%	Finish Type	%	Finish Type
95	Paraffin wax, dipped	69	Paraffin wax brushed	16	Acrylic latex flat house paint
82	Aluminum paint (linseed/phenolic/menhaden)	60	Alkyd house primer paint (tall maleic alkyd resin)	11	Water repellent (1% wax)
80	Enamel paint-satin (soya/tung)	59	Epoxy paint-gloss (1-component)	4	Acrylic latex house primer paint
		57	Marine enamel-gloss (soya alkyd)	2	Tung oil
		50	Epoxy varnish-gloss (1-component)	0	Semitransparent oil-based stain
		46	Floor and deck enamel (phenolic alkyd)	0	Solid-color latex stain (acrylic resin)
		44	Urethane varnish (oil modified)	0	Alkyd flat wall paint (soya alkyd)
		42	Solid-color oil-based stain (linseed oil)	0	Latex flat wall paint (vinyl acrylic resin)
		41	Oil-based house paint (tall/soya alkyds)	0	Paste furniture wax
		32	Flat latex primer wall paint (butadiene-styrene resin)	0	Linseed oil
		30	Spar varnish (soya alkyd)	0	Unfinished wood (control)

[1]Taken from Agricultural Handbook No. 647, USDA.
[2]100% = perfect protection or no absorption of water vapor; 0% = no protection as with unfinished wood.

Table 15-4.
Characteristics of woods for painting and weathering
(omissions in the table indicate inadequate data for classification)[1]

Wood	Ease of Keeping Well Painted; I—Easiest, V—Most Exacting[1]	Weathering		Appearance	
		Resistance to Cupping; 1—Best, 4—Worst	Conspicuousness of Checking; 1—Least, 2—Most	Color of Heartwood (Sapwood is Always Light)	Degree of Figure on Flat-Grained Surface
Cedar					
Alaska	I	1	1	Yellow	Faint
California incense	I	—	—	Brown	Do.
Western red cedar	I	1	1	Brown	Distinct
Redwood	I	1	1	Dark brown	Distinct
Products[1] overlaid with resin-treated paper	I	—	1	—	—
Pine					
Sugar	II	2	2	do.	Do.
Western white	II	2	2	do.	Do.
Ponderosa	III	2	2	do.	Distinct
Fir, commercial white	III	2	2	White	Faint
Hemlock	III	2	2	Pale brown	Do
Spruce	III	2	2	White	Do.
Doulgas-fir (lumber and plywood)	IV	2	2	Pale red	Strong
Larch	IV	2	2	Brown	Do.
Lauan (plywood	IV	2	2	do.	Faint
Pine					
Southern (lumber and plywood)	IV	2	2	do.	Strong

[1]From Agricultural Handbook No. 647, USDA.

[2]Plywood, lumber, and fiberboard with overlay or low-density surface.