In many ways, water is one of wood's worst enemies. Water plays a key role in the rapid weathering of wood exposed outdoors, in the performance of exterior finished wood, and in the decay or rotting of wood. Properly seasoned wood that stays dry is not subject to decay, to premature failure of paints and finishes, or to many of the other serious problems associated with weathering.

Fortunately, there are some relatively simple wood treatments that can be used to slow down the pickup of water and help keep wood dry. These treatments are called water repellents (WR). When a preservative is added to a WR, it is called a water-repellent preservative (WRP). The composition of these two treating materials is very similar; both contain a substance that repels water (usually paraffin).
wax or related material), a resin or drying oil, and a solvent such as turpentine or mineral spirits. Addition of a preservative such as pentachlorophenol or copper naphthenate to a water repellent helps to protect wood surfaces against decay and mildew organisms.

Homeowners can avoid many exterior wood-finishing problems by first treating with a WR or WRP solution to guard against damage to the wood and paint caused by water and by decay and stain fungi (mildew). WR or WRP treatment of wood is recommended both before painting and also as a natural finish for wood. Use of the WRP is recommended in areas where mildew growth is a problem or where decay may occur.

(The WR and WRP treatments are very effective when used on wood exposed outdoors above ground. In areas where decay is a serious problem, or where wood will be in contact with the ground (wood foundations or fence posts, for example), wood will need far more protection than that afforded by a surface treatment with a WR or WRP. In such cases, wood properly protected by treatment with a commercial preservative is recommended. Such treated wood is normally available at a lumberyard and should conform to recognized standards for maximum service life.)

A WR or WRP should be applied to all exterior wood that is normally painted. In a new house, lumber treated by the manufacturer (particularly for millwork items such as window frames) should be used, if possible, and all cut ends should be treated on the job by brushing or, preferably, dipping. If untreated lumber is used, all exterior surfaces should be treated.

Most WRP's are intended for exterior use because the preservatives in them, particularly pentachlorophenol, are toxic. Users must read the label on the original container carefully to determine if the material is allowed and recommended for indoor use. When in doubt, only a WR should be used, even outdoors, in case toxic chemicals should cause any problems such as contact with people, animals, or plants. The WR's, too, should be allowed and recommended for indoor use. The warning at the end of this publication has further information.

How Does a WR or WRP Work?

A WR or WRP is a solution that gives wood the ability to repel liquid water, such as rain and dew (fig. 1). They do this because they contain a waxlike substance. By repelling water, they resist decay and stain by denying fungi that cause these conditions the moisture they need to live. A WR or WRP also reduces water damage to the wood, such as the excessive swelling and shrinking that leads to cracking and warping. They protect paint from the blistering, cracking, and peeling that often occur when excessive water penetrates the wood. As mentioned earlier, a WRP also contains a fungicide—often pentachloro-
Applying WR or WRP to Wood

Applying WR or WRP solution to the surface of unfinished wood by brushing or by dipping is an effective treatment for siding and exterior millwork (doors, window sash, doors, and window frames, sills, moldings, fascia), for wood fencing, and for lawn furniture.

The following steps are suggested for application to new wood:

1. If treated siding or millwork is purchased, only freshly cut surfaces need to be brush or dip treated.
2. Wood that has not been factory treated can be treated by either brushing or dipping. Dipping is more effective. Care should be taken to treat ends of boards and joints between boards. Open joints should be caulked after treating and priming.
3. Freshly treated wood must be allowed to dry. If the treatment is applied with a brush, 2 days of warm favorable drying weather must be allowed before painting. If dipped for 10 seconds or more, 1 week of favorable drying weather is necessary before painting. If enough time is not allowed for most of the solvent to dry from the wood, the paint applied over it may be slow to dry, or may discolor or dry with a rough surface that looks like alligator leather.

When applying WR or WRP to previously painted wood, loose paint must be removed, the WR or
In most parts of the country, mildew grows on the wood surface and gives it a dark gray, blotchy, and unsightly appearance. In contrast, in very dry climates or in coastal regions where salt atmospheres may inhibit the growth of mildew, weathered wood often has a clean, silvery appearance.

The color of weathered wood is influenced to a lesser degree by highly colored wood extractives in such woods as western redcedar and redwood. These extractives gradually diffuse to the surface and produce a dark-brown color. This color may persist in protected areas not exposed to direct sun and rain. The extractives can be removed by scrubbing with detergent and rinsing.

A clean golden-tan color can be achieved in the weathering of wood by treating the surface to retard the accumulation of wood extractives and mildew. The treatment, originally recommended by the California Redwood Association,\(^2\) consists of applying a WRP to the wood surface. This method of finishing also is recommended for other siding species and for natural finishing of exterior plywood, brushed plywood, and low grades of lumber that do not hold paint well. The treatment also reduces warping and cracking and prevents water staining at edges and ends of wood siding. The WRP can be used for this purpose, but will not protect against mildew growth and subsequent graying.

Figure 4.—Closeup view of water-repellent-protected window unit and frame after 20 years’ exposure. Firm wood resists penetration by the knife blade.

WRP should be brushed into the joints only, and excess solution wiped from the paint surfaces with a rag. Two days of favorable warm drying weather must be allowed before repainting.

Whether treatment is to new wood or previously painted wood, particular care should be taken to apply the solution well at the ends of boards, at joints between boards, and to all newly exposed wood such as drill holes. Some homeowners do not realize that water will climb by capillary flow up the back of bevel siding from the lap joints. WR or WRP applied to lap joints of the siding does a good job of preventing capillary flow. Accordingly, places that should be treated well include the butt and lap joints of horizontal siding, edges and top and bottom ends of vertical siding, and the edges and corner joints in window sash, sills, window frames, doors, and door frames. Often bottoms of doors and window sash are overlooked. These are areas where water can penetrate deeply and cause extensive damage if not treated. Treatment with WR or WRP will eliminate many such problems later.

**Using WRP As An Exterior Natural Finish**

The color and appearance of weathered wood can be affected, to
The first application of the WRP is usually short-lived. When the wood surface starts to show blotchy discoloration caused by extractives and mildew, it should be cleaned by mild scrubbing with a detergent, followed by rinsing with water. Then another liberal brush application of water-repellent preservative solution should be applied.

Frequently, it is necessary to clean and re-treat smoothly planed wood surfaces after the first year of exposure. After cleaning and re-treating, the treatment should last much longer and need be refinished only when the surface starts to show an uneven discoloration pattern or small black spots indicating the start of mildew. The treatment will be more durable on weathered or rough-sawn surfaces because they absorb a greater quantity of solution than does a smooth surface.

Pigments in the form of colors in oil and tinting colors can also be added to the WRP solution to give a desired color effect and improve durability. A quantity of 4 to 6 fluid ounces of color per gallon of solution is usually adequate. Pigmented WRP should be applied to the full length of a course of siding without stopping, to avoid the formation of lap marks. Lap marks would also be minimized by applying two coats, the second coat applied before the first dries. Penetrating pigmented stains such as described in USDA Forest Service Research Note FPL-046 "Forest Products Laboratory Natural Finish," are considered much more durable than the WRP-type finish and can always be applied to wood previously finished with the WRP after the WRF-treated wood has had 1 year or more of weathering.

When wood weathers naturally, it is important to use nails that are highly resistant to rusting. Iron nails rust rapidly and produce a severe brown or black discoloration around the nail. Stainless steel and aluminum nails are corrosion-resistant and prevent such difficulties.

It is recommended that, for use in climates where mildew growth may be a problem—such as the southeastern part of the United States—WRP's should be prepared using exterior-grade varnish. Better performance of a WRP for these areas can be achieved by increasing the amount of pentachlorophenol to 2-3/4 cups per gallon.

Figure 5.—Closeup view of decayed untreated window unit frame. Window unit fell apart after 6 years' exposure.

M 145 288-8
Typical WR and WRP Solutions

Ingredients

WR and WRP solutions are widely made and distributed commercially and are available in most paint and lumber stores. Formulas for preparing these wood treatments are:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Water repellent (WR)</th>
<th>Water-repellent preservative (WRP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pentachlorophenol concentrate 10:1 (40%)</td>
<td>None</td>
<td>1-3/4 cups</td>
</tr>
<tr>
<td>Boiled linseed oil</td>
<td>1-1/2 cups</td>
<td>1-1/2 cups</td>
</tr>
<tr>
<td>Paraffin wax</td>
<td>1 oz</td>
<td>1 oz</td>
</tr>
<tr>
<td>Solvent (turpentine, mineral spirits, or paint thinner)</td>
<td>Add to make 1 gal</td>
<td>Add to make 1 gal</td>
</tr>
</tbody>
</table>

---

Approximate quantity for 1 gallon of

a/ Other preservatives used commercially include copper naphthenate, copper-8-quinolinolate, and bis (tri-n-butyltin) oxide. Recent Forest Products Laboratory exposure studies show that pentachlorophenol is a more effective mildewcide than copper naphthenate, which in turn is better than copper-8-quinolinolate or bis (tri-n-butyltin) oxide. In some states, PCP concentrate may be a restricted pesticide and unavailable.

b/ Exterior-grade varnish can be used in place of boiled linseed oil. If so, use twice the volume shown for linseed oil.

Mixing

Melt the paraffin wax in the top unit of a double boiler or some other container heated by hot water. **DON'T USE A DIRECT FLAME OR HEAT NEAR A FLAME SUCH AS THE PILOT LIGHT ON A STOVE—THE PARAFFIN WAX WILL IGNITE.**

The solvent should be at room temperature (60° to 80°F) before mixing. While vigorously stirring the solvent, slowly pour in the melted paraffin. After the paraffin wax and solvent are mixed, add—in order—linseed oil or varnish (and penta concentrate if WRP). Stir until the mixture is uniform. The ingredients may separate if the solution is stored at low or freezing temperatures. If this happens, warm the solution to room temperature and stir to redissolve the ingredients.

Safety First

In mixing and applying WR or WRP, care should always be exercised. The safest place to do the mixing is outdoors. The solutions are volatile, flammable mixtures. Don't breathe their vapors or expose them to flame or sparks. It is wise to wear protective clothing on the hands and arms and to take care that the solution is not splashed in the eyes or on the face. Be especially careful using WRP, as these solutions contain toxic materials.

**CAUTION:** Wood preservatives (a type of pesticide) can be injurious to man, animals, and plants. Therefore, for safe and effective usage, it is essential to follow the directions and heed all precautions on the labels. Some wood preservatives are toxic to humans and animals and may be root poisons and defoliants for plants. It is, therefore, advisable to wear rubber gloves and protective masks (approved for use with pesticides) and to cover nearby plant life when using any material, such as the FPL Natural Finish or a water-repellent preservative, containing preserv-
ative chemicals. The application of preservatives using any spray method can be especially hazardous and extra precautions must be taken. Avoid spraying whenever possible.

**DO NOT USE ANY PRESERVATIVES INDOORS UNLESS THEY HAVE BEEN SPECIFICALLY APPROVED AND RECOMMENDED FOR SUCH USE.**

Store preservatives in original containers under lock and key—out of reach of children and pets—and away from foodstuffs. Use all preservatives selectively and carefully. Follow recommended practices for the disposal of surplus preservatives and preservative containers.

**NOTE:** Registrations of preservatives are under constant review by the Environmental Protection Agency and the Department of Agriculture. Use only preservatives that bear a Federal registration number and carry directions for home and garden use. Because the registration of preservatives is under constant review by State and Federal authorities, a responsible State agency should be consulted as to the current status of this preservative.

---

**For Further Information**

Several Forest Service Research Notes touch on various phases of wood finishing. Single copies of these are available from the Forest Products Laboratory, Forest Service, U.S. Department of Agriculture, Box 5130, Madison, Wis. 53705.

**USDA Forest Service Research Notes:**

- FPL-046 Forest Products Laboratory Natural Finish
- FPL-0123 Wood Finishing: Painting Outside Wood Surfaces
- FPL-0126 Wood Finishing: Temperature Blistering of House Paints
- FPL-0127 Wood Finishing: Intercoat Peeling of House Paints
- FPL-0128 Wood Finishing: Mildew on House Paints
- FPL-0129 Wood Finishing: Cross-Grain Cracking of Oil-Base House Paints
- FPL-0131 Wood Finishing: Discoloration of House Paint by Blue Stain
- FPL-0132 Wood Finishing: Discoloration of House Paints by Water-Soluble Extractives in Western Redcedar and Redwood
- FPL-0133 Wood Finishing: Finishing Exterior Plywood
- FPL-0135 Wood Finishing: Weathering of Wood
- FPL-0232 How to Refinish Wood Siding with Latex Paints