CHAPTER 8

STRUCTURAL COATINGS AND PRESERVATIVES

The final stage of most construction projects is the application of protective coatings, or "painting." As with all projects, you should follow the plans and specifications for surface preparation and application of the finish coat. The specifications give all the information you need to complete the tasks. But, to have a better understanding of structural coatings, you need to know their purposes, methods of surface preparation, and application techniques.

PURPOSES OF STRUCTURAL COATINGS

LEARNING OBJECTIVE: Upon completing this section, you should be able to state the purposes of the different types of structural coatings and how each is employed.

The protection of surfaces is the most important consideration in determining the maintenance cost of structures. Structural coatings serve as protective shields between the base construction materials and elements that attack and deteriorate them. Regularly programmed structural coatings offer long-range protection, extending the useful life of a structure.

PREVENTIVE MAINTENANCE

The primary purpose of a structural coating is protection. This is provided initially with new construction and maintained by a sound and progressive preventive maintenance program. Programmed painting enforces inspection and scheduling. A viable preventive maintenance program will help ensure that minor problems are detected at an early stage—before they become major failures later. An added advantage derived from preventive maintenance is the detection of faulty structural conditions or problems caused by leakage or moisture.

Resistance to moisture from rain, snow, ice, and condensation constitutes perhaps the greatest single protective characteristic of paint, the most common type of structural coating. Moisture causes metal to corrode and wood to swell, warp, or rot. Interior wall finishes of buildings can be ruined by moisture entering through neglected exterior surfaces. Porous masonry is attacked and destroyed by moisture. Therefore, paint films must be as impervious to moisture as possible to provide a protective, water-proof film over the surface to which they are applied. Paint also acts as a protective film against acids, alkalies, material organisms, and other damaging elements.

SANITATION AND CLEANLINESS

Painting is an essential part of general maintenance programs for hospitals, kitchens, mess halls, offices, warehouses, and living quarters. Paint coatings provide smooth, nonabsorptive surfaces that are easily washed and kept free of dirt and foodstuffs. Adhering foodstuffs harbor germs and cause disease. Coating rough or porous areas seals out dust and grease that would otherwise be difficult to remove.

Odorless paints are used in these areas because conventional paint solvent odors are obnoxious to personnel. In food preparation areas, the odors maybe picked up by nearby food.

FIRE RETARDANCE

Certain types of structural coatings delay the spread of fire and assist in confining a fire to its area of origin. Fire-retardant coatings should not be considered substitutes for conventional paints. The use of fire-retardant coatings is restricted to areas of highly combustible surfaces, and must be justified and governed by the specific agency's criteria. Fire-retardant coatings are not used in buildings containing automatic sprinkler systems.

CAMOUFLAGE

Camouflage paints have special properties, making them different from conventional paints. Their uses are limited to special applications. Do not use camouflage paints as substitutes for conventional paints. Use this paint only on exterior surfaces to render buildings and structures inconspicuous by blending them in with the surrounding environment.

ILLUMINATION AND VISIBILITY

White and light-tinted coatings applied to ceilings and walls reflect both natural and artificial light and help brighten rooms and increase visibility. On the other hand, darker colors reduce the amount of reflected light. Flat coatings diffuse, soften, and evenly distribute illumination, whereas gloss finishes reflect more like mirrors and may create glare. Color contrasts improve visibility of the painted surface, especially when paint is applied in distinctive patterns. For example, white on black, white on orange, or yellow on black can be seen at greater distances than single colors or other combinations of colors.

IDENTIFICATION AND SAFETY

Certain colors are used as standard means of identifying objects and promoting safety. For example, fire protection equipment is painted red. Containers for kerosene, gasoline, solvents, and other flammable liquids should be painted a brilliant yellow and marked with large black letters to identify their contents. The colors of signal lights and painted signs help control traffic safely by providing directions and other travel information.

TYPES OF COATINGS

LEARNING OBJECTIVE: Upon completing this section, you should be able to identify the types of structural coatings and finishes, and the general characteristics of each.

As a Builder, you must consider many factors when selecting a coating for a particular job. One important factor is the type of coating, which depends on the composition and properties of the ingredients. Paint is composed of various ingredients, such as pigment, nonvolatile vehicle, or binder, and solvent, or thinner. Other coatings may contain only a single ingredient.

PAINT

In this section, we'll cover the basic components of paint—pigment, vehicles, and solvents—and explain the characteristics of different types of paint.

Composition

Paint is composed of two basic ingredients: pigment and a vehicle. A thinner may be added to change the application characteristics of the liquid.

PIGMENT.— Pigments are insoluble solids, ground finely enough to remain suspended in the vehicle for a considerable time after thorough stirring or shaking. Opaque pigments give the paint its hiding, or covering, capacity and contribute other properties (white lead, zinc oxide, and titanium dioxide are examples). Color pigments give the paint its color. These may be inorganic, such as chrome green, chrome yellow, and iron oxide, or organic, such as toluidine red and phthalocyanine blue. Transparent or extender pigments contribute bulk and also control the application properties, durability, and resistance to abrasion of the coating. There are other special-purpose pigments, such as those enabling paint to resist heat, control corrosion, or reflect light.

VEHICLES, OR BINDERS.— The vehicle, or binder, of paint is the material holding the pigment together and causing paint to adhere to a surface. In general, paint durability is determined by the resistance of the binder to the exposure conditions. Linseed oil, once the most common binder, has been replaced, mainly by the synthetic alkyd resins. These result from the reaction of glycerol phthalate and an oil and may be made with almost any property desired. Other synthetic resins, used either by themselves or mixed with oil, include phenolic resin, vinyl, epoxy, urethane, polyester, and chlorinated rubber. Each has its own advantages and disadvantages. When using these materials, it is particularly important that you exactly follow the manufacturers' instructions.

SOLVENTS, OR THINNERS.— The only purpose of a solvent, or thinner, is to adjust the consistency of the material so that it can be applied readily to the surface. The solvent then evaporates, contributing nothing further to the film. For this reason, the cheapest suitable solvent should be used. This solvent is likely to be naphtha or mineral spirits. Although turpentine is sometimes used, it contributes little that other solvents do not and costs much more.

NOTE

Synthetic resins usually require a special solvent. It is important the correct one be used; otherwise, the paint may be spoiled entirely.

Types

Paints, by far, comprise the largest family of structural coatings you will be using to finish products, both interior and exterior. In the following

section, we'll cover some of the most commonly encountered types.

OIL-BASED PAINTS.— Oil-based paints consist mainly of a drying oil (usually linseed) mixed with one or more pigments. The pigments and quantities of oil in oil paints are usually selected on the basis of cost and their ability to impart to the paint the desired properties, such as durability, economy, and color. An oil-based paint is characterized by easy application and slow drying. It normally chalks in such a manner as to permit recoating without costly surface preparation. Adding small amounts of varnish tends to decrease the time it takes an oil-based paint to dry and to increase the paint's resistance to water. Oil-based paints are not recommended for surfaces submerged in water.

ENAMEL.— Enamels are generally harder, tougher, and more resistant to abrasion and moisture penetration than oil-based paints. Enamels are obtainable in flat, semigloss, and gloss. The extent of pigmentation in the paint or enamel determines its gloss. Generally, gloss is reduced by adding lower cost pigments called extenders. Typical extenders are calcium carbonate (whiting), magnesium silicate (talc), aluminum silicate (clay), and silica. The level of gloss depends on the ratio of pigment to binder.

EPOXY.— Epoxy paints area combined resin and a polyamide hardener that are mixed before use. When mixed, the two ingredients react to form the end product. Epoxy paints have a limited working, or pot, life, usually 1 working day. They are outstanding in hardness, adhesion, and flexibility-plus, they resist corrosion, abrasion, alkali, and solvents. The major uses of epoxy paints are as tile-like glaze coatings for concrete or masonry, and for structural steel in corrosive environments. Epoxy paints tend to chalk on exterior exposure; low-gloss levels and fading can be anticipated. Otherwise, their durability is excellent.

LATEX.— Latex paints contain a synthetic chemical, called latex, dispersed in water. The kinds of latex usually found in paints are styrene-butadiene (so-called synthetic rubber), polyvinyl acetate (PVA or vinyl), and acrylic. Latex paints differ from other paints in that the vehicle is an emulsion of binder and water. Being water-based, latex paints have the advantage of being easy to apply. They dry through evaporation of the water. Many latex paints have excellent durability. This makes them particularly useful for coating plaster and masonry surfaces. Careful surface preparation is required for their use.

RUBBER-BASED.— Rubber-based paints are solvent thinned and should not be confused with latex binders (often called rubber-based emulsions). Rubber-based paints are lacquer-type products and dry rapidly to form finishes highly resistant to water and mild chemicals. They are used for coating exterior masonry and areas that are wet, humid, or subject to frequent washing, such as laundry rooms, showers, washrooms, and kitchens.

PORTLAND CEMENT.— Portland cement mixed with several ingredients acts as a paint binder when it reacts with water. The paints are supplied as a powder to which the water is added before being used. Cement paints are used on rough surfaces, such as concrete, masonry, and stucco. They dry to form hard, flat, porous films that permit water vapor to pass through readily. When properly cured, cement paints of good quality are quite durable. When improperly cured, they chalk excessively on exposure and may present problems in repainting.

ALUMINUM.— Aluminum paints are available in two forms: ready mixed and ready to mix. Ready-mixed aluminum paints are supplied in one package and are ready for use after normal mixing. They are made with vehicles that will retain metallic brilliance after moderate periods of storage. They are more convenient to use and allow for less error in mixing than the ready-to-mix form.

Ready-to-mix aluminum paints are supplied in two packages: one containing clear varnish and the other, the required amount of aluminum paste (usually two-thirds aluminum flake and one-third solvent). You mix just before using by slowly adding the varnish to the aluminum paste and stirring. Ready-to-mix aluminum paints allow a wider choice of vehicles and present less of a problem with storage stability. A potential problem with aluminum paints is moisture in the closed container. When present, **moisture may react with the aluminum flake to form hydrogen gas that pressurizes the container.** Pressure can cause the container to bulge or even pop the cover off the container. Check the containers of ready-mixed paints for bulging. If they do, puncture the covers carefully before opening to relieve the pressure. Be sure to use dry containers when mixing aluminum paints.

VARNISHES

In contrast to paints, varnishes contain little or no pigment and do not obscure the surface to which applied. Usually a liquid, varnish dries to a hard,

transparent coating when spread in a thin film over a surface, affording protection and decoration.

Of the common types of varnishes, the most important are the oils, including spar, flat, rubbing, and color types. These are extensively used to finish and refinish interior and exterior wood surfaces, such as floors, furniture, and cabinets. Spar varnish is intended for exterior use in normal or marine environments, although its durability is limited. To increase durability, exterior varnishes are especially formulated to resist weathering.

Varnishes produce a durable, elastic, and tough surface that normally dries to a high-gloss finish and does not easily mar. Often, a lower gloss may be obtained by rubbing the surface with a very fine steel wool. However, it is simpler to use a flat varnish with the gloss reduced by adding transparent-flatting pigments, such as certain synthetic silicas. These pigments are dispersed in the varnish to produce a clear finish that dries to a low gloss, but still does not obscure the surface underneath (that is, you can still see the grain of the wood).

SHELLAC

Shellac is purified lac formed into thin flakes and widely used as a binder in varnishes, paints, and stains. (Lac is a resinous substance secreted by certain insects.) The vehicle is wood alcohol. The natural color of shellac is orange, although it can be obtained in white. Shellac is used extensively as a finishing material and a sealant. Applied over knots in wood, it prevents bleeding.

LACQUERS

Lacquers may be clear or pigmented and can be lusterless, semigloss, or glossy. Lacquers dry or harden quickly, producing a firm oil- and water-resistant film. But many coats are required to achieve adequate dry-film thickness. It generally costs more to use lacquers than most paints.

STAINS

Stains are obtainable in four different kinds: oil, water, spirit, and chemical. Oil stains have an oil vehicle; mineral spirits can be added to increase penetration. Water stains are solutions of aniline dyes and water. Spirit stains contain alcohol. Chemical stains work by means of a chemical reaction when dissolved by water. The type of stain to use depends largely on the purpose, the location, and the type of wood being covered.

SURFACE PREPARATION

LEARNING OBJECTIVE: Upon completing this section, you should be able to describe the procedures used in preparing surfaces for painting.

The most essential part of any painting job is proper surface preparation and repair. Each type of surface requires specific cleaning procedures. Paint will not adhere well, provide the protection necessary, or have the desired appearance unless the surface is in proper condition for painting. Exterior surface preparation is especially important because hostile environments can accelerate deterioration.

METALS

As a Builder, you are most likely to paint three types of metals: ferrous, nonferrous, and galvanized. Improper protection of metals is likely to cause fatigue in the metal itself and may result in costly repairs or even replacement. Correct surface preparation, prior to painting, is essential.

Ferrous

Cleaning ferrous metals, such as iron and steel, involves the removal of oil, grease, previous coatings, and dirt. Keep in mind that once you prepare a metal surface for painting, it will start to rust immediately unless you use a primer or pretreatment to protect the surface.

Nonferrous

The nonferrous metals are brass, bronze, copper, tin, zinc, aluminum, nickel, and others not derived from iron ore. Nonferrous metals are generally cleaned with a solvent type of cleaner. After cleaning, you should apply a primer coat or a pretreatment.

Galvanized

Galvanized iron is one of the most difficult metals to prime properly. The galvanizing process forms a hard, dense surface that paint cannot penetrate. Too often, galvanized surfaces are not prepared properly, resulting in paint failure. Three steps must be taken to develop a sound paint system.

1. Wash the galvanized surface with a solvent to remove grease, waxes, or silicones. Manufacturers sometimes apply these to resist “white rust” that may form on galvanized sheets stored

under humid conditions. Mineral spirits or acid washes should definitely not be used at this stage.

2. Etch the surface with a mild phosphoric acid wash. Etching increases paint adhesion and helps overcome the stress forces generated by expansion and contraction of the galvanized coating. After acid washing the surface, rinse it with clean water and allow to dry. When using acid, remember the situation can represent actual or potential danger to yourself and other employees in the area. Continuous and automatic precautionary measures minimize safety problems and improve both efficiency and morale of the crew.

3. Apply a specially formulated primer. Two basic types of primer are in common use: zinc-bound and cementitious-resin. The zinc-bound type is used for normal exposure. Most types of finish can be used over this type of primer. Latex emulsion paints provide a satisfactory finish. Oil-based products should not be used over cementitious-resin primers. A minimum of two coats of finish is recommended over each type of primer.

CONCRETE AND MASONRY

In Navy construction, concrete and masonry are normally not painted unless painting is required for damp-proofing. Cleaning concrete and masonry involves the removal of dirt, mildew, and efflorescence (a white, powdery crystalline deposit that often forms on concrete and masonry surfaces).

Dirt and Fungus

Dirt and fungus are removed by washing with a solution of trisodium phosphate. The strength of the solution may vary from 2 to 8 ounces per gallon of water, depending upon the amount of dirt or mildew on the surface. Immediately after washing, rinse off all the trisodium phosphate with clear water. If using oil paint, allow the surface to dry thoroughly before painting.

Efflorescence

For efflorescence, first remove as much of the deposit as possible by dry brushing with a wire brush or a stiff fiber brush. Next, wet the surface thoroughly with clear water; then, scrub with a stiff brush dipped in a 5-percent solution (by weight) of muriatic acid. Allow the acid solution to remain on the surface about 3 minutes before scrubbing, but rinse thoroughly with clear water immediately after scrubbing. Work on small areas not larger than 4 square feet. Wear rubber gloves, a rubber apron, and goggles when mixing and applying the acid solution. In mixing the acid, always add acid to water. **Do not add water to acid; this can cause the mixture to explode.** For a very heavy deposit, the acid solution may be increased to 10 percent and allowed to remain on the surface for 5 minutes before it is scrubbed.

Repairing Defects

All defects in a concrete or masonry surface must be repaired before painting. To repair a large crack, cut the crack out to an inverted-V shape and plug it with grout (a mixture of two or three parts of mortar sand, one part of portland cement, and enough water to make it putty-like in consistency). After the grout sets, damp cure it by keeping it wet for 48 hours. If oil paint is to be used, allow at least 90 days for weathering before painting over a grout-filled crack.

PLASTER AND WALLBOARD

Whenever possible, allow new plaster to age at least 30 days before painting if oil-based paint is being applied. Latex paint can be applied after 48 hours, although a 30-day wait is generally recommended. Before painting, fill all holes and cracks with spackling compound or patching plaster. Cut out the material along the crack or hole in an inverted-V shape. To avoid excessive absorption of water from the patching material, wet the edges and bottom of the crack or hole before applying the material. Fill the opening to within 1/4 inch of the surface and allow the material to set partially before bringing the level up flush with the surface. After the material has thoroughly set (depending on the type of filler used), use fine sandpaper to smooth out the rough spots. Plaster and wallboard should have a sealer or a prime coat applied before painting. When working with old work, remove all loose or scaling paint, sand lightly, and wash off all dirt, oil, and stains. Allow the surface to dry thoroughly before applying the new finish coat.

WOOD

Before being painted, a wood surface should be closely inspected for loose boards, defective lumber, protruding nail heads, and other defects or irregularities. Loose boards should be nailed tight, defective lumber should be replaced, and all nail heads should be countersunk.

A dirty wood surface is cleaned for painting by sweeping, dusting, and washing with solvent or soap and water. In washing wood, take care to avoid

excessive wetting, which tends to raise the grain. Wash a small area at a time, then rinse and dry it immediately.

Wood that is to receive a natural finish (meaning not concealed by an opaque coating) may require bleaching to a uniform or light color. To bleach, apply a solution of 1 pound of oxalic acid to 1 gallon of hot water. More than one application may be required. After the solution has dried, smooth the surface with fine sandpaper.

Rough wood surfaces must be sanded smooth for painting. Mechanical sanders are used for large areas, hand sanding for small areas. For hand sanding, you should wrap sandpaper around a rubber, wood, or metal sanding block. For a very rough surface, start with a coarse paper, about No. 2 or 2 1/2. Follow this with a No, 1/2, No. 1, or No. 1 1/2. You should finish with about a No. 2/0 grit. For fine work, such as furniture sanding, you should finish with a freer grit.

Sap or resin in wood can stain through a coat, or even several coats, of paint. Remove sap or resin by scraping or sanding. Knots in resinous wood should be treated with knot sealer.

Green lumber contains a considerable amount of water, most of which must be removed before use. This not only prevents shrinkage after installation, but prevents blistering, cracking, and loss of adhesion after applied paint. Be sure all lumber used has been properly dried and kept dry before painting.

CONDITIONERS

Conditioners are often applied on masonry to seal a chalky surface to improve adhesion of water-based

Table 8-1.—Treatments of Various Substrates

MECHANICAL	WOOD	METAL		CONCRETE AND MASONRY	PLASTER AND WALLBOARD
		Steel	Other		
Hand Cleaning	S	S	S	S	S
Power Tool Cleaning	S*	S	S	S	
Flame Cleaning		S			
Blast Cleaning			S		
Brush-Off		S		S	
All Other		S			
Chemical and Solvent			S		
Solvent Cleaning	S	S			
Alkali Cleaning		S		S	
Steam Cleaning		S		S	
Acid Cleaning		S		S	
Pickling		S			
Pretreatments					
Hot Phosphate		S			
Cold Phosphate		S	S		
Wash Primers		S			
Conditioners, Sealers, and Fillers					
Conditioners				S	
Sealers	S				
Fillers	S			S	

S—Satisfactory for use as indicated
*—Sanding only

topcoats. Sealers are used on wood to prevent resin running or bleeding. Fillers are used to produce a smooth finish on open-grained wood and rough masonry. Table 8-1 presents the satisfactory treatments of the various surfaces.

Since water-thinned latex paints do not adhere well to chalky masonry surfaces, an oil-based conditioner is applied to the chalky substrate before latex paint is applied. The entire surface should be vigorously wire brushed by hand or power tools, then dusted to remove all loose particles and chalk residue. The conditioner is then brushed on freely to assure effective penetration and allowed to dry. Conditioner is not intended for use as a finish coat.

SEALERS

Sealers are applied to bare wood like coats of paint. Freshly exuded resin, while still soft, may be scraped off with a putty knife and the area cleaned with alcohol. Remove hardened resin by scraping or sanding. Since sealer is not intended as a prime coat, it should be used only when necessary and applied only over the affected area. When previous paint becomes discolored over knots on pine lumber, the sealer should be applied over the old paint before the new paint is applied.

FILLERS

Fillers are used on porous wood, concrete, and masonry to provide a smoother finish coat.

Wood

Wood fillers are used on open-grained hardwoods. In general, hardwoods with pores larger than those found in birch should be filled. Table 8-2 lists the characteristics of various woods and which ones require fillers. The table also contains notes on finishing. Filling is done after staining. Stain should be allowed to dry for 24 hours before the filler is

Table 8-2.-Characteristics of Wood

NAME OF WOOD	TYPE OF GRAIN			NOTES ON FINISHING
	SOFT	HARD		
	Closed	Open	Closed	
Ash		X		Requires filler
Alder	X			Stains well
Aspen			X	Paints well
Basswood			X	Paints well
Beech			X	Paints poorly; varnishes well
Birch			X	Paints and varnishes well
Cedar	X			Paints and varnishes well
Cherry			X	Varnishes well
Chestnut		X		Requires filler; paints poorly
Cottonwood			X	Paints well
Cypress			X	Paints and varnishes well
Elm		X		Requires filler; paints poorly
Fir	X			Paints poorly
Gum			X	Varnishes well
Hemlock	X			Paints fairly well
Hickory		X		Requires filler
Mahogany		X		Requires filler
Maple			X	Varnishes well
Oak		X		Requires filler
Pine	X			Variable depending on grain
Teak		X		Requires filler
Walnut		X		Requires filler
Redwood	X			Paints well

Note: Any type of finish may be applied unless otherwise specified

applied. If staining is not warranted, natural (uncolored) filler is applied directly to the bare wood. The filler may be colored with some of the stain to accentuate the grain pattern of the wood.

To apply, you first thin the filler with mineral spirits to a creamy consistency, then liberally brush it across the grain, followed by a light brushing along the grain. Allow it to stand 5 to 10 minutes until most of the thinner has evaporated. At this time, the finish will have lost its glossy appearance. Before it has a chance to set and harden, wipe the filler off across the grain using burlap or other coarse cloth, rubbing the filler into the pores of the wood while removing the excess. Finish by stroking along the grain with clean rags. All excess filler must be removed.

Knowing when to start wiping is important. Wipng too soon pulls the filler out of the pores. Allowing the filler to set too long makes it hard to wipe off. A simple test for dryness consists of rubbing a finger across the surface. If a ball is formed, it's time to wipe. If the filler slips under the pressure of the finger, it is still too wet for wiping. Allow the filler to dry for 24 hours before applying finish coats.

Masonry

Masonry fillers are applied by brush to bare and previously prepared (all loose, powdery, flaking material removed) rough concrete, concrete block, stucco, or other masonry surfaces. The purpose is to fill the open pores in the surface, producing a fairly smooth finish. If the voids on the surface are large, you should apply two coats of filler, rather than one heavy coat. This avoids mud cracking. Allow 1 to 2 hours drying time between coats. Allow the final coat to dry 24 hours before painting.

PAINT MIXING AND CONDITIONING

LEARNING OBJECTIVE: Upon completing this section, you should be able to describe the techniques used in mixing and applying paint.

Most paints used in the Navy are ready-mixed, meaning the ingredients are already combined in the proper proportions. When oil paint is left in storage for long periods of time, the pigments settle to the bottom. These must be remixed into the vehicle before the paint is used. The paint is then strained, if necessary. All paint should be placed in the paint shop at least 24 hours before use. This is to bring the paint to a temperature between 65°F and 85°F.

There are three main reasons to condition and mix paint. First, you need to redisperse, or reblend, settled pigment with the vehicle. Second, lumps, skins, or other impediments to proper application need to be

Table 8-3.—Mixing Procedures

COATING	EQUIPMENT	REMARKS
Enamel, semigloss, or flat paints (oil type)	Manual, propeller, or shaker	Mix until homogeneous
Water-based paints (latex type)	Manual or propeller	Use extreme care to avoid air entrapment
Clear finishes	Manual, propeller, or shaker	Generally require little or no mixing
Extremely viscous finishes; for example, coal tar paints	Drum-type mixer	Use extreme care to avoid air entrapment
Two-package metallic paints; for example, aluminum paints	Propeller	Add small amount of liquid to paste; mix well. Slowly add remainder of vehicle, while stirring, until coating is homogeneous. With metallic powder, first make into a paste with solvent, and then proceed as above
Two-Component Systems	Propeller, shaker, or drum-type mixer	Mix until homogeneous. Check label for special instructions

eliminated. And, third, the paint must be brought to its proper application temperature.

MIXING

Paints should be mixed, or blended, in the paint shop just before they are issued. Mixing procedures vary among different types of paints. Regardless of the procedure used, try not to overmix; this introduces too much air into the mixture. Table 8-3 outlines the types of equipment and remarks for various coatings. Mixing is done by either a manual or mechanical method. The latter is definitely preferred to ensure maximum uniformity. Manual mixing is less efficient than mechanical in terms of time, effort, and results. It should be done only when absolutely necessary and be limited to containers no larger than 1 gallon. Nevertheless, it is possible to mix 1-gallon and 5-gallon containers by hand. To do so, first pour half of the paint vehicle into a clean, empty container. Stir the paint pigment that has settled to the bottom of the container into the remaining paint vehicle. Continue to stir the paint as you return the other half slowly to its original container. Stir and pour the paint from can to can. This process of mixing is called boxing paint. The mixed paint must have a completely blended appearance with no evidence of varicolored swirls at the top. Neither should there be lumps of undispersed solids or foreign matter. Figure 8-1 illustrates the basic steps for boxing paint.

There are only three primary true-pigmented colors: red, blue, and yellow. Shades, tints, and hues are derived by mixing these colors in various proportions. Figure 8-2 shows a color triangle with one primary color at each of its points. The lettering

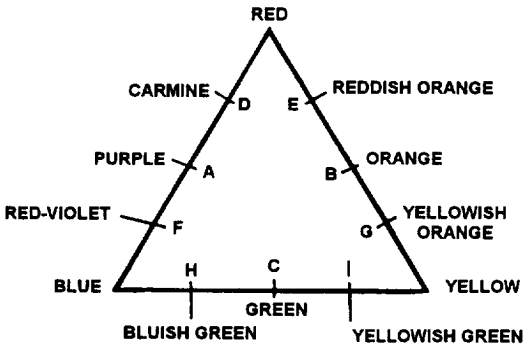

Figure 8-2.—A color triangle.

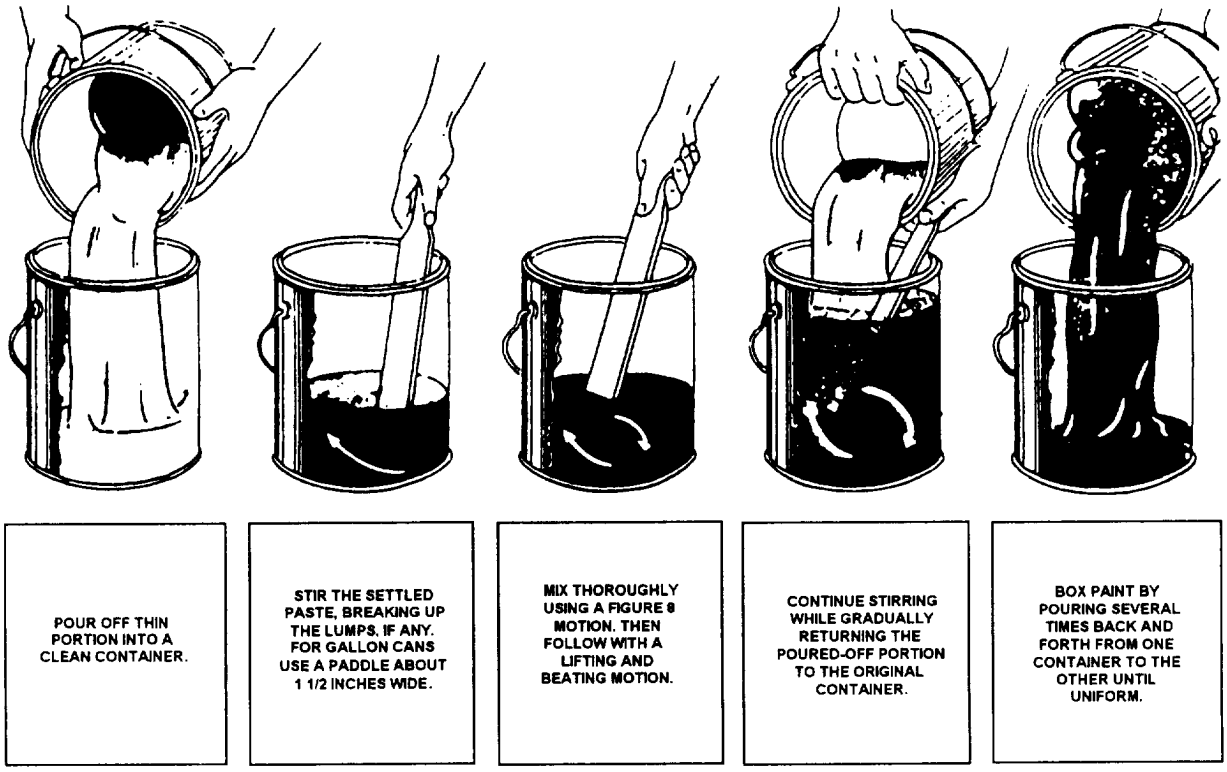

Figure 8-1.—Manual mixing and boxing.

in the triangle indicates the hues that result when colors are mixed.

A— Equal proportions of red and blue produce purple.

B— Equal proportions of red and yellow produce orange.

C— Equal proportions of blue and yellow produce green.

D— Three parts of red to one part of blue produce carmine.

E— Three parts of red to one part of yellow produce reddish orange.

F— Three parts of blue to one part of red produce red-violet.

G— Three parts of yellow to one part of red produce yellowish orange.

H— Three parts of blue to one part of yellow produce bluish green.

I— Three parts of yellow to one part of blue produce yellowish green.

Hues are known as chromatic colors, whereas black, white, and gray are achromatic (neutral colors). Gray can be produced by mixing black and white in different proportions.

Thinning

When received, paints should be ready for application by brush or roller. Thinner can be added for either method of application, but the supervisor or inspector must give prior approval. Thinning is often required for spray application. Unnecessary or excessive thinning causes an inadequate thickness of the applied coating and adversely affects coating longevity and protective qualities. When necessary, thinning is done by competent personnel using only the thinning agents named by the specifications or label instructions. Thinning is not done to make it easier to brush or roll cold paint materials. They should be preconditioned (warmed) to bring them up to 65°F to 85°F.

Straining

Normally, paint in freshly opened containers does not require straining. But in cases where lumps, color flecks, or foreign matter are evident, paints should be strained after mixing. When paint is to be sprayed, it must be strained to avoid clogging the spray gun.

Skins should be removed from the paint before mixing. If necessary, the next step is thinning. Finally, the paint is strained through a fine sieve or commercial paint strainer.

Tinting

Try not to tint paint. This will reduce waste and eliminate the problem of matching special colors at a later date. Tinting also affects the properties of the paint, often reducing performances to some extent. One exception is the tinting of an intermediate coat to differentiate between that coat and a topcoat; this helps assure you don't miss any areas. In this case, use only colorants of known compatibility. Try not to add more than 4 ounces of tint per gallon of paint. If more is added, the paint may not dry well or otherwise perform poorly.

When necessary, tinting should be done in the paint shop by experienced personnel. The paint must be at application viscosity before tinting. Colorants must be compatible, fresh, and fluid to mix readily. Mechanical agitation helps distribute the colorants uniformly throughout the paint.

APPLICATION

The common methods of applying paint are brushing, rolling, and spraying. The choice of method is based on several factors, such as speed of application, environment, type and amount of surface, type of coating to be applied, desired appearance of finish, and training and experience of painters. Brushing is the slowest method, rolling is much faster, and spraying is usually the fastest by far. Brushing is ideal for small surfaces and odd shapes or for cutting in corners and edges. Rolling and spraying are efficient on large, flat surfaces. Spraying can also be used for round or irregular shapes.

Local surroundings may prohibit the spraying of paint because of fire hazards or potential damage from over-spraying (accidentally getting paint on adjacent surfaces). When necessary, adjacent areas not to be coated must be covered when spraying is performed. This results in loss of time and, if extensive, may offset the speed advantage of spraying.

Brushing may leave brush marks after the paint is dry. Rolling leaves a stippled effect. Spraying yields the smoothest finish, if done properly. Lacquer products, such as vinyls, dry rapidly and should be sprayed. Applying them by brush or roller may be difficult, especially in warm weather or outdoors on

breezy days. The painting method requiring the most training is spraying. Rolling requires the least training.

PAINT FAILURES

LEARNING OBJECTIVE: Upon completing this section, you should be able to identify the common types of coating failures and recognize the reasons for each.

A coating that prematurely reaches the end of its useful life is said to have failed. Even protective coatings properly selected and applied on well-prepared surfaces gradually deteriorate and eventually fail. The speed of deterioration under such conditions is less than when improper painting procedures are earned out. Inspectors and personnel responsible for maintenance painting must recognize signs of deterioration to establish an effective and efficient system of inspection and programmed painting. Repainting at the proper time avoids the problems resulting from painting either too soon or too late. Applying coatings ahead of schedule is costly and eventually results in a heavy buildup that tends to quicken deterioration of the coating. Applying a coating after it is scheduled results in costly surface preparation and may be responsible for damage to the structure, which may then require expensive repairs.

In the following sections, we'll look at some of the more common types of paint failures, the reasons for such failures, methods of prevention, and cures.

SURFACE PREPARATION FAULTS

Paint failures can result from many causes. Here, we'll look at some of the most common caused by faults in surface preparation.

Alligatoring

Alligatoring (fig. 8-3) refers to a coating pattern that looks like the hide of an alligator. It is caused by uneven expansion and contraction of the undercoat. Alligatoring can have several causes: applying an enamel over an oil primer; painting over bituminous paint, asphalt, pitch, or shellac; and painting over grease or wax.

Peeling

Peeling (fig. 8-4) results from inadequate bonding of the topcoat with the undercoat or the underlying surface. It is nearly always caused by inadequate surface preparation. A topcoat peels when applied to a wet, dirty, oily or waxy, or glossy surface. All glossy surfaces must

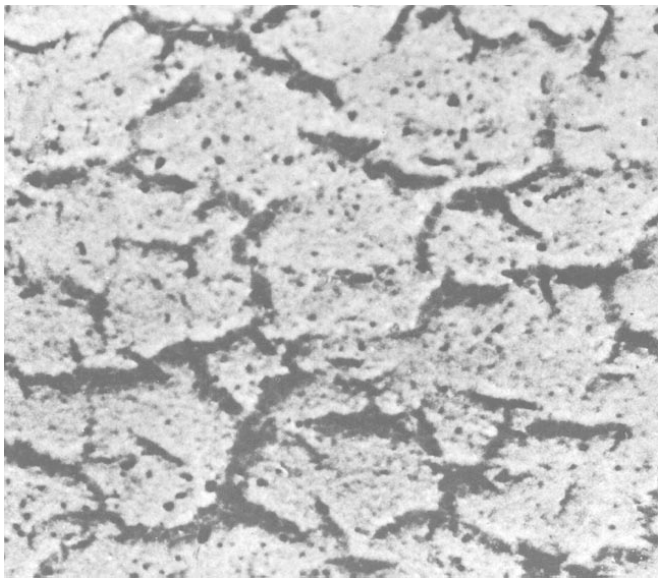

Figure 8-3.—Alligatoring.

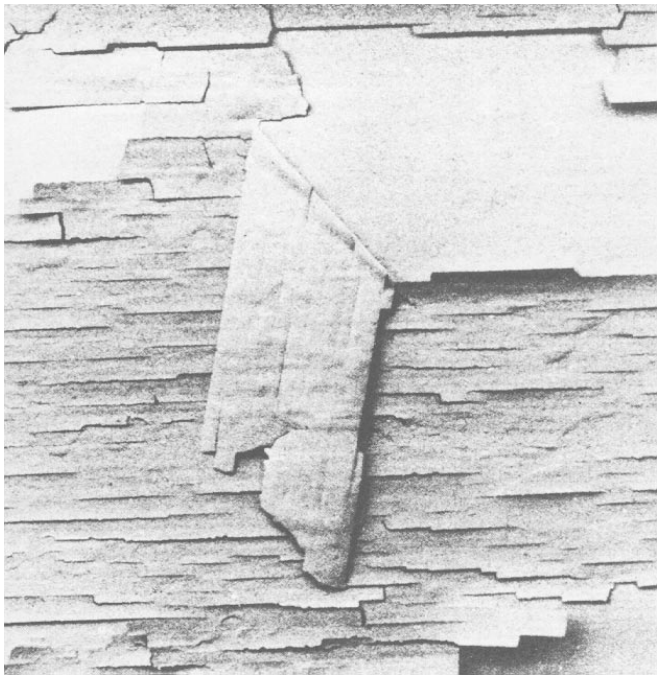

Figure 8-4.—Peeling.

be sanded before painting. Also, the use of incompatible paints can cause the loss of adhesion. The stresses in the hardening film can then cause the two coatings to separate and the topcoat to flake and peel.

Blistering

Blistering is caused by the development of gas or liquid pressure under the paint. Examples are shown

in figure 8-5. The root cause of most blistering, other than that caused by excessive heat, is inadequate ventilation plus some structural defect allowing moisture to accumulate under the paint. A prime source of this problem, therefore, is the use of essentially porous major construction materials that allow moisture to pass through. Insufficient drying time between coats is another prime reason for blistering. All blisters should be scraped off, the paint edges feathered with sandpaper, and the bare places primed before the blistered area is repainted.

Prolonged Tackiness

A coat of paint is dry when it ceases to be "tacky" to the touch. Prolonged tackiness indicates excessively slow drying. This may be caused by insufficient drier in the paint, a low-quality vehicle in the paint, applying the paint too thickly, painting over an undercoat that is not thoroughly dry, painting over a waxy, oily, or greasy surface, or painting in damp weather.

Inadequate Gloss

Sometimes a glossy paint fails to attain the normal amount of gloss. This may be caused by inadequate surface preparation, application over an undercoat that is not thoroughly dry, or application in cold or damp weather.

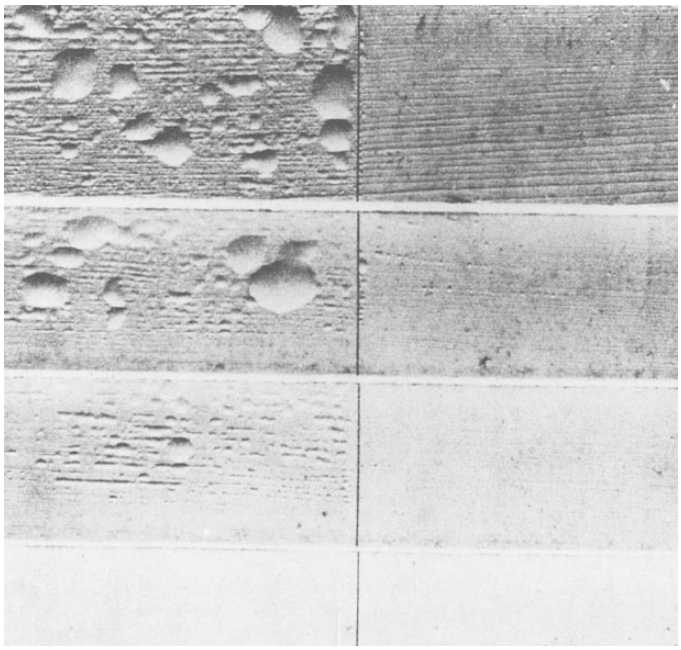

Figure 8-5.—Blistering.

IMPROPER APPLICATION

One particular area you, as a Builder, have direct control over is application. It takes a lot of practice, but you should be able to eliminate the two most common types of application defects: crawling and wrinkling.

Crawling

Crawling (fig. 8-6) is the failure of a new coat of paint to wet and form a continuous film over the preceding coat. This often happens when latex paint is applied over high-gloss enamel or when paints are applied on concrete or masonry treated with a silicone water repellent.

Wrinkling

When coatings are applied too thickly, especially in cold weather, the surface of the coat dries to a skin over a layer of undried paint underneath. This usually causes wrinkling (fig. 8-7). Wrinkling can be avoided in brush painting or roller painting by brushing or rolling each coat of paint as thinly as possible. In spray painting, you can avoid wrinkling by keeping the gun in constant motion over the surface whenever the trigger is down.

PAINT DEFECTS

Not all painting defects are caused by the individual doing the job. It sometimes happens that the coating itself is at fault. Chalking, checking, and cracking are the most common types of product defects you will notice in your work as a Builder.

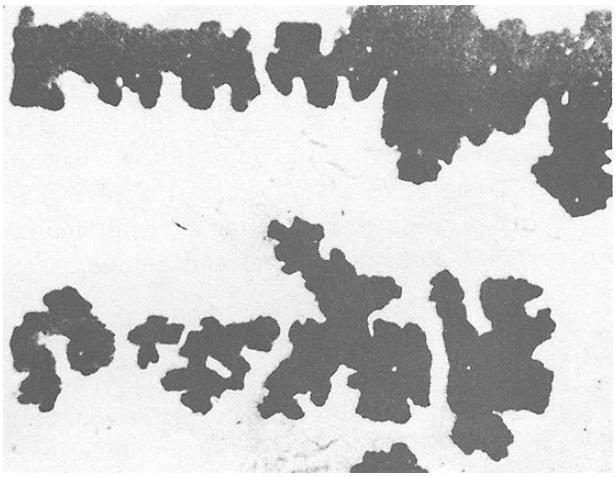

Figure 8-6.-Crawling.

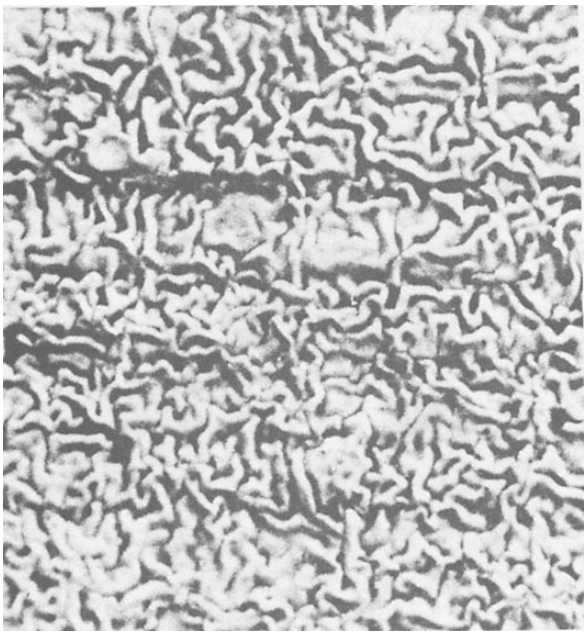

Figure 8-7.—Wrinkling.

Chalking

Chalking (fig. 8-8) is the result of paint weathering at the surface of the coating. The vehicle is broken down by sunlight and other destructive forces, leaving behind loose, powdery pigment that can easily be rubbed off with the finger. Chalking takes place rapidly with soft paints, such as those based on linseed oil. Chalking is most rapid in areas exposed to sunshine. In the Northern Hemisphere, for example, chalking is most rapid on the south side of a building. On the other hand, little chalking takes place in areas protected from sunshine and rain, such as under eaves or overhangs. Controlled chalking can be an asset, especially in white paints where it acts as a self-cleaning process and helps to keep the surface clean and white. The gradual wearing away reduces the thickness of the coating, thus allowing continuous repainting without making the coating too thick for satisfactory service.

Do not use a chalking or self-cleaning paint above natural brick or other porous masonry surfaces. The chalking will wash down and stain or discolor these areas.

Chalked paints are generally easier to repaint since the underlying paint is in good condition and requires little surface preparation. But, this is not the case with water-thinned paints; they adhere poorly to chalky surfaces.

Checking and Cracking

Checking and cracking are breaks in a coating formed as the paint becomes hard and brittle. Temperature changes cause the substrate and overlying paint to expand and contract. As the paint becomes hard, it gradually loses its ability to expand without breaking. Checking (fig. 8-9) consists of tiny breaks in only the upper coat or coats of the paint film

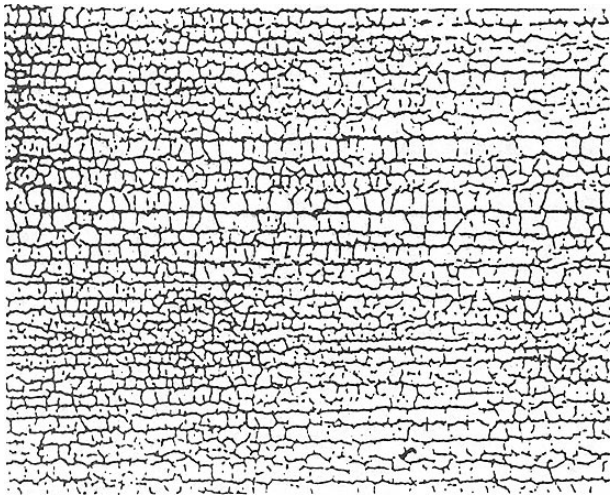

Figure 8-9.—Severe checking.

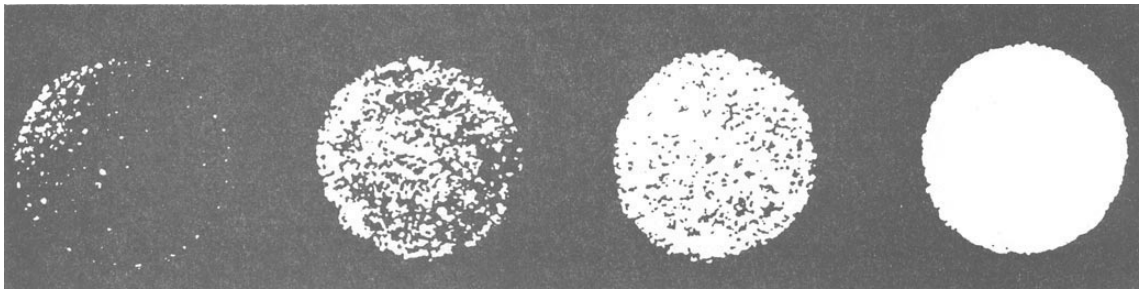

Figure 8-8.—Degrees of chalk.

without penetrating to the substrate. The pattern is usually similar to that of a crow's foot. Cracking is larger with longer breaks extending through to the substrate (fig. 8-10). Both result from stresses exceeding the strength of the coating. But, whereas checking arises from stress within the paint film, cracking is caused by stresses between the film and the substrate.

Cracking generally takes place to a greater extent on wood, due to its grain, than on other substrates. The stress in the coating is greatest across the grain, causing cracks to form parallel to the grain of the wood. Checking and cracking are aggravated by excessively thick coatings that have reduced elasticity. Temperature variations, humidity, and rainfall are also concerns for checking or cracking.

WOOD PRESERVATIVES

LEARNING OBJECTIVE: Upon completing this section, you should be able to describe how to treat wood for protection against dry rot, termites, and decay.

There are three destructive forces against which most wood protective measures are directed: biological deterioration (wood is attacked by a number of organisms), fire, and physical damage. In this section, we'll deal with protecting wood products against biological deterioration.

Damage to wood buildings and other structures by termites, wood bores, and fungi is a needless waste. The ability of wood to resist such damage can be greatly increased by proper treatment and continued maintenance. Wood defects are also caused by improper care after preservation treatment. All surfaces of treated wood that are cut or drilled to expose the untreated interior must be treated with a wood preservative.

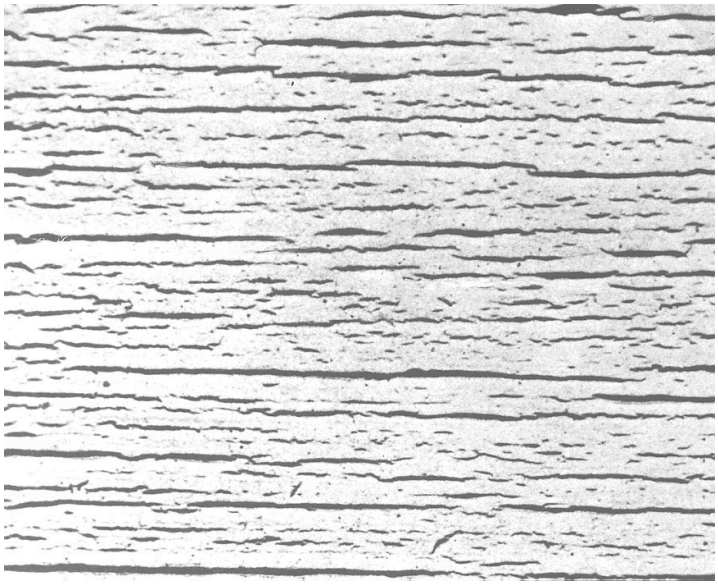

Figure 8-10.-Severe cracking.

APPLICATION METHODS

There are two basic methods for treating wood: pressure and nonpressure. Pressure treatment is superior to nonpressure, but costly and time consuming. Building specifications dictate which method to use.

Pressure

The capacity of any wood to resist dry rot, termites, and decay can be greatly increased by impregnating the wood with a general-purpose wood preservative or fungicide. It's important to remember that good **pressure** treatment adds to the service life of wood in contact with damp ground. It does not, however, **guarantee** the wood will remain serviceable throughout the life of the building it supports.

Woods of different timber species do not treat with equal ease. Different woods have different capacities for absorbing preservatives or other liquids. In any given wood, sapwood is more absorbent than heartwood. Hardwoods are, in general, less absorbent than softwoods. Naturally, the extent to which a preservative protects increases directly with the depth it penetrates below the surface of the wood. As we just mentioned, the best penetration is obtained by a pressure method. Table 8-4 shows the ease of preservative penetration into various woods. In the table, use E for easy, M for moderate, and D for difficult.

Nonpressure

Nonpressure methods of applying preservatives to a surface include dipping, brushing, and spraying. Figure 8-11 shows how you can improvise long tanks for the dipping method. Absorption is rapid at first, then much slower. A rule of thumb holds that in 3 minutes wood absorbs half the total amount of preservative it will absorb in 2 hours. However, the extent of the penetration depends upon the type of wood, its moisture content, and the length of time it remains immersed.

Surface application by brush or spray is the least satisfactory method of treating wood from the

Table 8-4.—Preservative Penetration

SPECIES	RELATIVE EASE OF GETTING PENETRATION INTO	
	Sapwood	Heartwood
Pines (most species)	E	M to D
Ponderosa pine	E	M
White fir	E	M
Most other true firs	E to M	D
Eastern hemlock	M	D
Western hemlock	E	E to M
Redwood	M to D	M to D
Douglas fir (Coast)	E to M	M to D
Douglas fir (Rocky Mountain)	D	D
Western larch	E	D
Sitka spruce	M	M
Most other spruces	D	D
Western red cedar	D	D
White oak	E	D
Selected red oaks	E	E

Notes: E—Easy; M—Moderate; D—Difficult

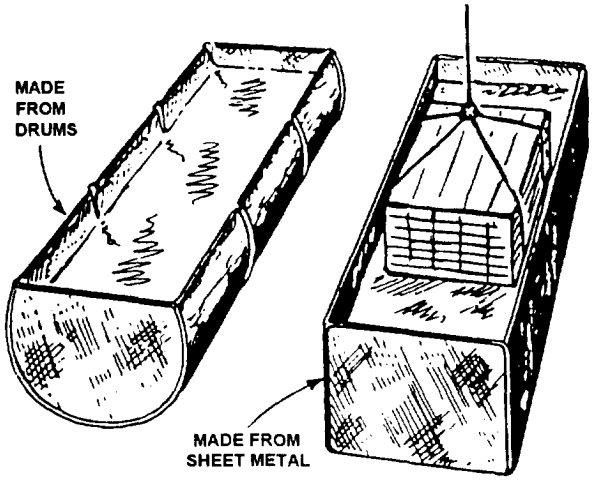

Figure 8-11.—Improvised tanks for dip treating lumber.

standpoint of maximum penetration. However, it is more or less unavoidable in the case of already installed wood, as well as treated wood that has been cut or drilled to expose the untreated interior.

FIELD-MIXED PRESERVATIVES

Pentachlorophenol and creosote coal tar are likely to be the only field-mixed preservatives used by the Builder. The type of treatment or preservative depends on the seventy of exposure and the desired life of the end product.

Preservatives can be harmful to personnel if improperly handled. When applying preservatives, you should take the following precautions:

- Avoid undue skin contact;
- Avoid touching the face or rubbing the eyes when handling pretreated material;
- Avoid inhalation of toxic (poisonous) material;
- Work only in a properly ventilated space and use approved respirators; and
- Wash with soap and water after contact.

PAINTING SAFETY

LEARNING OBJECTIVE: Upon completing this section, you should be able to state the principal fire and health hazards associated with painting operations.

Every painting assignment exposes Builders to conditions and situations representing actual or potential danger. Toxic and flammable materials,

pressurized equipment, ladders, scaffolding, and rigging always make painting a hazardous job. Hazards may also be inherent in the very nature of the environment or result from ignorance or carelessness by the painter.

The main causes of painting accidents are unsafe working conditions or equipment, and careless personnel. The proper setting up and dismantling of equipment, the required safety checks, and the proper care of equipment may require more time than is spent using it. Nevertheless, safety measures must be taken.

FIRE HAZARDS

Certain general rules regarding fire and explosion hazards apply to all situations. All paint materials should have complete label instructions stipulating the potential fire hazards and precautions to be taken. Painters must be advised and reminded of the fire hazards that exist under the particular conditions of each job. They need to be aware of the dangers involved and the need to work safely. Proper fire-fighting equipment must always be readily available in the paint shop, spray room, and other work areas where potential fire hazards exist. Electric wiring and equipment installed or used in the paint shop, including the storage room and spray room, must conform to the applicable requirements of the National Electrical Code (NEC) for hazardous areas.

HEALTH HAZARDS

Many poisons, classified as toxic and skin-irritating, are used in the manufacture of paint. Although your body can withstand small quantities of poisons for short periods, overexposure can have harmful effects. Continued exposure to even small amounts may cause the body to become sensitized; subsequent contact, even in small amounts, may cause an aggravated reaction. The poisons in paint are definite threats to normally healthy individuals and serious dangers to persons having chronic illnesses or disorders. Nevertheless, health hazards can be avoided by a common-sense approach of avoiding unnecessary contact with toxic or skin-imitating materials.

As with all tasks the Builder undertakes, safety must be a primary concern from the earliest planning stages to the final cleanup. Shortcuts, from personnel protection to equipment-related safety devices, should not be permitted. Follow the project safety plan, and consult all applicable safety manuals when involved with any paint operation. Remember, work safe, stay safe.

RECOMMENDED READING LIST

NOTE

Although the following references were current when this TRAMAN was published, their continued currency cannot be assured. You therefore need to ensure that you are studying the latest revisions.

Paints and Protective Coatings, NAVFAC MO-110, Departments of the Army, Navy, and Air Force, Washington, D.C., 1991.

Wood Preservation, NAVFAC MO-312, Department of the Navy, Naval Facilities Engineering Command, Washington, D.C., 1968.