Surface Preparation

Why Proper Surface Preparation is Vital to Maximum Performance of Paints & Coatings

No matter how good the coating, its effective service life can be shortened by insufficient or ineffective surface preparation. For maximum performance of a paint or coating, the surface must be adequately prepared to effect positive and long lasting adhesion of the coating to the substrate. This results only when contaminants (such as mill scale, rust scale, chemicals, grease, oil, dirt, weld splatter and failed old coatings) that adversely affect adhesion are removed.

Obviously, a properly selected coating system will outlast an improperly selected system under the same conditions. But with correct surface preparation, the properly selected coating system delivers maximum performance through an even longer service life, further reducing the annual cost of protective maintenance.

CONCRETE

I) General

Concrete is composed essentially of three materials: cement, water and aggregates. A fourth material, called an admixture, is sometimes added for a variety of specific purposes such as entrainment of air, acceleration or retardation of setting and hardening.

Cement makes up 10 to 15% of the total volume, aggregate occupies about 66 to 78%. The remaining volume is water.

The water in concrete serves a dual function. It first converts the dry cement and aggregates into a plastic mass. The water then reacts with cement chemically to hydrate and harden the mass.

The aggregate, which may be fine or coarse, is bound together by the hydrating cement and gives cured cement its basic strength. A mixture of cement and water with no aggregate is weak, brittle, and not a suitable substrate for paint.

Concrete that is used for walls or floors is usually reinforced with steel bars called "re-bar." This steel network is placed in the form or mold and the plastic concrete poured around it.

Concrete cures to a good strength in 28 days. The minimum amount of water required to place the concrete must be used - since excess water greatly weakens concrete.

II) Types Of Concrete To Be Painted

1) Poured In Place -The freshly mixed concrete is carried to the site by truck or conveyor and dumped into previously placed forms. Vibrators are used to remove as much air as possible and to assist the flow of plastic concrete into all shapes and corners of the form.

2) Tilt Up - Wet concrete is poured into flat, horizontal forms pieced on the floor of the building under construction. After curing to sufficient strength, these slabs are lifted into place. Depending on the design of the form, either the top, troweled side or the bottom or form side may be the exterior of the building.

3) Troweled Floors - Painting concrete floors is a difficult and painstaking job. Most failures occur because the mason over-trowels the surface, bringing weak slurry of water and cement to the surface. Concrete with little or no aggregate is called "laitance" and is not strong enough to take hard impact.

Steel troweling to a dense, hard surface prevents the first or seal coat from penetrating the surface and gaining adequate adhesion. Floors to be painted should be somewhat open, and porous.

Floors to be painted should not be treated with waxes, hardeners or curing membranes. They should be kept wet by moisture spray and burlap covers to assure complete surface curing.

4) Concrete Blocks -Concrete blocks vary so greatly that they cannot be put in a single category. For most concrete blocks, special block filler must be used before painting, if waterproofing is required.

5) Exposed Aggregate Panels -The special aggregate is spread in a thin layer on the bottom of the form and the wet concrete poured over it. After the concrete has cured, the panel is lifted and the still green, retarded mortar washed from over and around the aggregate particles.

III) Form Release Agents For Concrete

1) Function - A form release agent must perform several functions.

- Permits a clean release of the form from the hardened concrete.
- Leave a surface that is as hard and durable as the concrete itself.
- Provide protection for the form material so it may be reused.
- Allow satisfactory binding of protective and decorative finishes.

2) Classifications - Most form release agents are one of the following types:

- Straight petroleum oils - effective but excess amounts will cause paint failure.
- Waxes - effective but can cause paint failure.
- Oil emulsions - may cause discoloration.
- Lacquer, shellac and resin coatings - these are usually clear, varnish type coatings that seal the form which may be reused.
- Resins in solvent - widely used for lift-slab and tilt-up operations. They produce very little staining when used according to directions.
- Chemically active coatings - combine with calcium and aluminum hydroxide to form a soap which then releases concrete from form.
- Lacquer, shellac and resin coatings - these are usually clear, varnish type coatings that seal the form which may be reused.

IV) Painting Over Release Agents

Form release agents may cause adhesion problems either when the wrong agent is used or when an agent designed for accepting paint is used in excess. The severity of the problem depends to a great extent on the type, strength and thickness of the coating to be applied.

1) Architectural Coatings - Latex masonry paints are designed to have good adhesion over properly used form release agents. They have film builds usually under 4 mils per system. The film has greater adhesion than cohesion so minor film damage does not spread.

2) HIPAC Coatings (High Performance Architectural Coatings) - The strong, high-build coatings made from epoxy and polyurethane resins may fail if the system is not anchored into the pores of the concrete, irrespective of form release agents. Therefore, the form release agents should be removed and the surface pores opened so the first or seal coat can penetrate.

V) Surface Preparation Methods

The importance, type and degree of preparation required before painting depends on the type and condition of concrete, the exposure, and the coating system to be applied. The concrete should be clean, dry and free of dust, dirt, oil, mortar spatter and form release build-up.

1) Broom Cleaning - Remove all surface dust, dirt and other contaminants by brooming, air blast or vacuum clearer.

2) Acid Etching - The objective of acid etching is to dissolve the weak surface layer known as laitance and open the pores to allow penetration of the sealer coat. A solution of muriatic acid is usually used. The required strength will vary from 2% to 20% depending on the type of concrete mix and finishing given the concrete. The acid will cause a bubbling of the solution as it etches the surface concrete.

After the reaction ceases, the dissolved salts must be vigorously rinsed and scrubbed away, using repeated rinsing. The surface will feel like fine sandpaper if the etching action was effective.

The surface, when dry, should be free of any white deposit and ring hard under a knife blade.

Acid etching will not be effective over form release agents, most curing membranes, or most surface hardeners and is not practical - on a wall or ceiling area. It cannot be used to remove greases, oils, or other types of contaminants. Such contaminants must be removed by detergent or other appropriate solutions **before** the acid etch procedure is started.

3) Sandblasting - The most effective surface preparation method for concrete is a light blast with fine silica sand.

The objective is the same as acid etching. The blast removes all form release agents, weak concrete, laitance, dirt and contamination. It is effective on walls and ceilings as well as floors. Sandblasting is, however, dirty and expensive. It is usually not feasible in areas containing machinery and equipment or in areas where traffic is heavy and close. In such areas, self-contained centrifugal blasting equipment may be appropriate for horizontal surfaces.

Sandblasting is very effective for removing unsound or unwanted old coatings from concrete or masonry surfaces.

4) Hand Tool Cleaning - Sanding, wire brushing, solvent wiping, chipping and grinding all may be used to remove form oils, laitance and protrusions from small areas of concrete but are not very practical for cleaning large ceiling, wall or floor surfaces.

5) Scarifying - Power scarifiers may be used to remove the top layer of concrete to expose a fresh, clean surface. This technique is practical only for floors and is quite expensive. Dust protection is required when used in the presence of machinery, food or close traffic.

6) High Pressure Water Blasting - Water blasting at 3500-4500psi removes loose concrete, mortar, eroded and weak concrete, dirt and chemical contamination. It will not remove laitance, oil, grease or sound old coatings. Water blasting is dust free but requires good drainage to dispose of the large volume of water.

VI) Previously Painted Surfaces or Dirty Concrete

Unless the floor is in perfect condition, the biggest problem is dirty concrete. If oil or grease has penetrated concrete pores, the floor may be non-paintable.

To best remove oil and grease, sprinkle dry clean powder detergent over entire area. Spray with hot water and allow solution to stand for 10-16 minutes. Scrub vigorously with a stiff bristled brush. Rinse well, preferably with a steam-cleaning machine and dry.

A good test for residual oil or grease may be made by suspending a 60-watt incandescent light bulb 6 inches from surface and burning for 30 minutes. Check for fresh oil contamination on the surface. Repeat cleaning operation until no oil is present. If oil remains, high performance coating systems will probably fail.

A similar cleaning procedure or just steam cleaning with hot detergent will clean tight, old coatings. All loose and peeling paint must be scraped or sandblasted back to sound adhesion.

VII) Filling, Patching & Smoothing Concrete

The surface of poured or pre-cast concrete may contain holes caused by water or air pockets. Cracks, form patterns and other imperfections may be present. If the surface needs to be made smooth and even prior to application of the coating system, some type of surfacing material must be applied by trowel, brush or squeegee.

1) Organic Mastics Patching Material - Converted epoxies can be formulated for application by trowel, brush or squeegee. Force the mastic into the holes. Smooth with trowel or squeegee. Allow to cure as directed.

This treatment leaves a very strong surface suitable for HIPAC coatings or for immersion.

2) Latex Patching Materials - Latex patching materials apply easily, adhere to new or aged concrete and provide fairly smooth, void free surfaces. Use for light duty maintenance or architectural coatings. Trowel or squeegee to force into voids.

VIII) Moisture Content

Properly mixed concrete contains water in excess of that required to hydrate the cement. This excess water is maintained during the first thirty days or so by means of fine sprays, burlap-covers, plastic sheets and curing agents.

After this time, the concrete is exposed to ventilating air and the excess moisture allowed to evaporate.

Most architectural coatings are breathers and may be applied during this evaporation period without damage to the paint system.

The HIPAC coatings are vapor barriers and will not permit passage of moisture, either liquid or vapor. Moisture content must be down to a level acceptable to the coating manufacturer before application of the seal coat.

In general 30 days curing and 30 days with ventilation will be sufficient. Moisture meters are available for concrete and are effective in the hands of an expert inspector.

In no case should epoxy, epoxy-polyester or polyurethane systems be applied until the moisture level is down to a safe and approved level as determined by a qualified inspector.

CONCRETE FLOORS

I) General

The cleanliness and condition of a concrete floor is of prime importance to the durability and adhesion of any coating applied over it. Emphasis must be placed on the surface preparation and cleaning of the concrete. The following information will describe the conditions which must be coped with when painting, coating or sealing industrial concrete floors and the surface preparation required for optimum coating performance.

II) New Concrete Conditions

1) Laitance - The surface of new concrete is always weak, even on good high strength concrete, because troweling methods and the curing process encourage lighter components such as surplus Portland Cement and water to rise to the surface. When this cement-rich scum sets, it is called "laitance." Laitance is present to a depth of approximately 1/16-inch and is very weak and brittle. Unless the laitance layer is removed, stresses put on the laitance layer during use of the floor will very likely cause disintegration of the laitance and disbondment of any applied coating.

2) Curing Compounds - These materials are often sprayed onto wet concrete to act as membranes, which retard water evaporation while the concrete is curing. Curing compounds reduce rapid volume change in the concrete, thus reducing shrinkage. They are used in place of the **wet cure method**, which is the placement of wet burlap and/or 8 to 10 mil polyethylene or treated kraft paper over the surface of the wet concrete.

Sprayed-on curing compounds are wax or resin based materials, which leave an almost invisible film on the surface of the cured concrete and will prevent the proper adhesion of coatings to the concrete substrate. If possible, prohibit the use of curing compounds on new concrete floor slabs. If curing compounds are used, they must be removed before any subsequent surface preparation takes place and any coating is applied. A test method to determine their presence will be given later.

3) Hardeners - Solutions of various chemicals are frequently applied to new concrete floor slabs to reduce dusting (the breaking away of non-reacted Portland Cement particles). These chemicals react with the concrete, producing a slick, hard, dense surface, which cannot be directly coated. This reaction often hardens the concrete to a depth of 1/4 inch or more. It is difficult to visually detect the presence of most hardeners. A test method for their detection will be described later.

Fluorosilicates can be removed effectively by double etching (see below).

Sodium silicates as well as zinc sulfates and sodium sulfates produce a surface layer which acid or chemicals will not remove. The only effective means of removing them is by scarification or by thorough blast cleaning. **Do not attempt to coat a floor treated with these hardeners without first removing them by mechanical abrasion.**

Dry shake hardeners (metallic or non-metallic) are shaken onto fresh wet concrete behind the first power floating operation, creating denser, stronger, non-dusting slabs. It is necessary to etch floors treated with these materials. Mechanical abrasion is not normally required.

4) Concrete Curing Time - New concrete contains much water, some of which is surplus. Before any coating system is applied, the wet concrete must be permitted to cure (age) for as long as possible in order to reduce the moisture content and to permit the major part of the floor slab shrinkage to take place. The initial water content and thickness of the slab, the preparation of the underlying surface, the prevailing climatic conditions (relative humidity, air temperature, substrate temperature, heat-sink-on-grade, mix temperature of concrete) and the presence or absence of accelerating or retarding additives in the concrete all have a great effect on the curing time required prior to coating.

For slabs-on-grade not subject to freeze-thaw cycling, 30 days is generally considered the minimum curing time prior to painting. This 30-day period assumes an average or mean drying temperature of 70°F. In the winter and early spring, when a heat sink is present on grade (such as would be the case in an unheated, closed industrial building), a typical 6" Portland Cement concrete wearing slab should be allowed to cure for 60 days.

When slabs-on-grade are thicker than 24", allow to cure for 90 days at 70°F mean temperature prior to coating. In periods of intense heat, reduce curing time of thick slabs by 50%.

5) Accelerators - Special ingredients ("accelerators") can be added to concrete to speed up the cure rate. When accelerators are incorporated into the mix, the initial cure time may be reduced by a third depending upon the specific accelerator used. If an accelerator has been added to the concrete, the manufacturer should be contacted to determine how it will effect the cure time. Accelerators reduce the water/cement ratio, improve workability, and aid in cold weather concreting schedules.

III) Old Concrete (In Service) Conditions

In addition to the conditions mentioned above for new concrete, concrete that has been in service may be contaminated with oils, grease or chemicals and may have been previously coated. The presence of any contaminants or coatings must be determined, and appropriate surface preparation performed.

Deterioration of the concrete may have occurred due to the environment. The soundness of the floor must be evaluated. The feasibility of coating the floor and/or the appropriate preparation will depend upon this evaluation.

IV) Preparation Of Concrete Substrates

IMPORTANT NOTE: When using any of the equipment or chemical solutions described below, be sure to follow all manufacturer's instructions and follow any recommended safety procedures.

1) Mechanical Cleaning - The preparation of concrete using certain mechanical methods has the advantage of speed. If the more rigorous methods such as blasting or scarifying are attempted by insufficiently trained operators, however, removal of too much of the surface can easily result in exposed aggregate and an overly rough and porous surface. It must be realized that improperly performed mechanical preparation can severely damage a concrete floor.

- **Hand or Power Tool Cleaning**

  Wire brushing is used to remove loose matter from the surface and to a lesser extent to open voids and holes before coating. Either power or hand wire brushing is suitable, but the former method is normally used because it is faster and more efficient. Impact tools can be used to roughen the surface. This operation is slow and would normally be considered only for touch-up work.

  Power grinding, sanding or scraping can be used to open holes and voids and to remove curing membranes, some hardeners, loose matter and laitance from the surface of floor slabs. These methods can be used in place of blasting but are considerably slower and less effective.

- **Abrasive Blasting**

  Abrasive blasting is used to clean concrete floors in areas where this operation is permissible. Wet and dry blasting are available. Wet blasting is used to eliminate dusting and for safety in hazardous areas. Properly performed abrasive blasting removes loose and powdery concrete along with laitance. The resulting surface must be hard with surface voids opened and must have a profile, which is satisfactory for coating adhesion. The blast nozzle must be kept at a distance, which will provide satisfactory results and not overly damage the concrete. A 16-40-mesh sand is normally used as the abrasive medium because it gives the desired results at low cost.

- **Portable Centrifugal Blast Cleaning**

  Portable centrifugal blast cleaning equipment provides a self-contained cleaning system. Metallic abrasive is propelled by a rapidly rotating blast wheel and scours the concrete surface. The abrasive rebounds along with removed contaminants into a recovery system. Pulverized abrasive, dust, and contaminants are removed into a dust collector. Usable abrasive is returned for reuse.

- **Scarifying**

  When inspection and testing procedures indicate concrete floors must be chipped down to sound concrete, scarifying and scabbling machines can be used to perform this operation. Equipment can be purchased or rented in some locations.

2) Chemical Cleaning - As an alternative to mechanical methods, the preparation of concrete floors for coatings application can be accomplished by using chemical cleaning methods. Capitalized solvents or solutions mentioned below, such as Membrane Remover, are available.

- **Solvent Cleaning**

  Emulsifiable solvents such as Membrane Remover and the cleaner are a balance of detergents, solvents and emulsifiers. They are soluble in water. They are powerful cleaners, which very effectively cut through and remove rubber burns, grease, oil and stubborn soilage and hold these contaminants in suspension for easy pick up with a wet vacuum or other disposal method. The Membrane Remover may also be used to remove many types of curing membranes. Thorough rinsing with fresh water must follow the use of these solvents. If the Membrane Remover is used, rinsing with the Cleaner must precede the final water rinse.

- **Stripping**

  The removal of certain prior coatings, sealers and curing membranes will require the use of a solution such as the Stripper followed by thorough cleaning to remove all residues.

- **Chemical Contamination Removal**

  Chemically contaminated concrete must be cleaned and/or neutralized before further preparation such as acid etching or blasting can be done and before the application of any coating system. If the surface is acidic, it must be neutralized with an alkaline cleaner and rinse thoroughly with fresh water. If contaminated with alkali, the concrete must be cleaned with steam or with a detergent. Concrete contaminated with oils, grease or fats must be cleaned with an alkaline detergent or emulsifiable solvent.

- **Etching**

  Etching is a very low cost chemical method commonly used to treat concrete floors to remove laitance and provide a profile. Concentrated 32-36% (20° Baume) Muriatic Acid (hydrochloric acid) diluted with water is normally used. The volume dilution ratio can range from 1 part acid to 3 parts water to as weak as 1 part acid to 10 parts water depending upon the floor being treated.

  The surface is pre-dampened and the diluted acid applied uniformly over an appropriate area. The approximate spreading rate is 50-75 square feet for each gallon of acid mixture. The acid should remain on the surface for two to three minutes of bubbling reaction.

After application of the acid, scrub the surface with a stiff bristle pavement, scrubbing broom or rotary power scrubber will facilitate the etching process. The vigorous formation of bubbles indicates proper etching and must be obtained. The absence of bubbles or a weak reaction indicates the presence of a curing compound membrane or a surface hardener on the concrete. After etching is completed, thorough rinsing with fresh water must be done before the surface dries - in order to avoid the formation of salts on the surface. Once formed, these salts are difficult to remove. Any residual acidity must be neutralized with an alkaline cleaner followed by thorough rinsing with fresh water.

A properly etched concrete surface will be hard but porous and will have a profile similar to that of fine sandpaper. Water will penetrate easily and will hot bead up on the surface. In many cases, more than one etching operation is required to obtain a satisfactory result. The etching solution should never be more concentrated than 1 part acid to 3 parts water. If satisfactory results are not obtained with this concentration, repeat the etching procedure. If the surface is rougher than fine sandpaper after one etching, more dilute acid solutions (dilution up to 1 part acid to 10 parts water) should be used.

In addition to muriatic acid, proprietary etchants, which contain phosphoric acid and concentrated cleaners, are available and may also be used.

IMPORTANT SAFETY INFORMATION: Both hydrochloric and phosphoric acids cause burns to skin and eyes, and the inhalation of acid fumes may be harmful. During the etching operation, wear chemical resistant gloves made of materials such as neoprene or polyvinyl chloride, chemical splash goggles and 8" minimum face shield, impervious clothing and boots. If the TLV is exceeded, wear a NIOSH/MSHA approved supplied air respirator. When diluting acid with water, always add the acid to the water to avoid the possible rapid generation of heat and resultant splattering. Refer to the etching material's Material Safety Data Sheet for complete safe handling and cautionary statements. Hydrochloric acid is volatile and should not be used where there are stainless steel objects or sensitive mechanical or electrical equipment in the area being etched. Precautions should be taken to prevent the spread of hydrochloric acid fumes into other areas where sensitive equipment or metals may be found. As an alternative to etching with hydrochloric acid, the use of phosphoric acid (which is non-volatile) should be considered in sensitive situations.

V) The Survey – Inspection / Testing Procedures And Analysis

The first step in evaluating surface preparation requirements is to make a visual inspection to determine the condition of the concrete surface.

It is important to know the history of the existing concrete. This should include not only the chemicals to which it has been exposed (if old concrete) but also construction details such as: was the concrete placed directly on soil or clay or is there a sand or gravel drainage bed? Is there a vapor barrier? How far under the floor is the water table?

The concrete should be inspected for porosity, exposed aggregate, cracks, laitance, evidence of surface hardeners or the presence of a curing compound membrane. Any evidence of moisture or damp or wet spots on the floor should also be noted.

1) Testing for Surface Soundness - Determine the soundness of the surface by scratching it with a screwdriver, file or pocketknife. The metal object should ride over the surface without loosening any particles, leaving no more than a shiny mark. If this process leaves a gouge, the surface is not sound and will not support a polyurethane or epoxy high-performance coating system.

Another method used to test for soundness is to strike the surface with the edge of a hammerhead. If the hammer rebounds sharply leaving no more than a small fracture, the surface is sound. If it lands with a dull thud and leaves powder in the indentation, the surface is not considered sound or paintable.

An unsound surface may be caused by the presence of laitance, degradation of the concrete due to chemical attack, an improper concrete mix, improper cure, or other factors. If due to laitance or chemical attack, sound concrete will likely be present under the weak surface. In any event, the floor must be tested by using chemical or abrasive methods to remove the unsound concrete. If a sound surface can be expose in this way, the floor is paintable after the required preparation has been performed.

2) Testing For Moisture - Inspect the concrete for moisture by first looking for damp or wet spots on the floor. Note any leakage from other areas which must be eliminated prior to the application of the coating system. Check for hidden dampness by using a polyethylene cover test: tape an 18"x 18" sheet of 4 mil thick (minimum) polyethylene to the floor at various locations where moisture conditions may vary, such as near exterior walls, near the center of the building, and on any below grade areas. Make sure that the sheet is completely sealed to the floor. Check the sheet after 16-24 hours. If beads of water show on the underside of the sheet, there is sufficient water vapor present to interfere with the adhesion of a coating system. As described in ASTM Method D 4263, this test is preferred to the use of a moisture meter, which may give inconclusive results.

3) Testing For Suitable Cleaning Method - Before deciding on any particular method, clean several relatively small areas to assess the efficiency of the method and the appearance and condition of the surface after cleaning. The reasons for cleaning must be considered carefully because results with methods intended to improve only the appearance of the surface can differ substantially from results obtained with methods intended to prepare the surface for a heavy-duty urethane or epoxy coating.

The floor surface should be tested in a number of places to ensure that the entire area to be coated does not contain oil or grease contamination. Areas around machinery, pumps and equipment subject to heavy spillage of oils and other contaminants should be closely inspected and tested. Grease and oil can be effectively removed using the Membrane Remover (emulsifiable solvent). If the floor has been previously saturated with oil or fats, the use of the Elcometer Adhesion Tester in conjunction with the cleaning tests will indicate if the contaminants have been sufficiently removed. The tester's loading fixture is bonded directly to the uncoated cleaned surface and then removed using the detaching assembly (refer to ASTM Method D 4541). Insufficient cleaning can be identified by a clean separation of the bonding adhesive from the concrete surface with no removal of the concrete itself.

The following five-step procedure can be used to determine a suitable chemical preparation method. Note that if two test applications of any of the solutions are required to properly prepare the surface, a similar double application will be required when the entire floor is prepared. CAUTION: Wear protective clothing, gloves and goggles and, if necessary, respiratory protection when performing these tests. When diluting acid with water, always add acid to water.

a) Treat several small areas (one to ten square feet) with an etchant. A mixture of 1 part concentrated muriatic acid and 3 parts water is recommended for testing. If the solution bubbles vigorously producing a uniform white foam or haze of bubbles and leaves a clean surface, there is no curing membrane or hardener. Beware of a weak or partial reaction, which can occur if a thin layer of curing membrane or hardener is present. in many cases, more than one etch is required. If the reaction is not vigorous or does not occur, move on to step b. If a single etching results in a surface which is appreciably rougher than fine sandpaper, the test should be repeated with more dilute acid solutions (dilution up to 1 part acid to 10 parts water) until an etched profile similar to fine sandpaper is obtained.

b) This method will remove many types of curing membranes. Scuff sand several test areas, sweep or vacuum up all sanding debris, and then apply the etchant as in step a. If the reaction is not vigorous or does not occur, re-apply the etchant. If the reaction is still weak or is not present, proceed to step c.

c) This method will remove acrylic or chlorinated rubber membranes or sealers (thermoplastics) with chlorinated rubber being the most difficult, sometimes requiring two applications. Apply the Membrane Remover to a small area. After allowing the Remover to stand 20-30 minutes, scrub the area with non-woven abrasive or stiff bristle brush, clean with the Cleaner, rinse with fresh water, and then treat with etchant as in step a. A vigorous formation of bubbles indicates that hardeners or curing compound membranes have been removed. If the reaction is not vigorous or does not occur, move on to step d.

d) Epoxy ester and alkyd modified urethane sealers (thermosets) will require the use of the Stripper. Scrub a small area with non-woven abrasive and the Stripper. Rinse with the Cleaner and then treat with etchant as in step a. A vigorous formation of bubbles indicates that the sealer has been removed. If there is no reaction, move on to step e.

e) Failure of the previous tests indicates the presence of a hardener, which cannot be removed chemically. Remove concrete to a depth of at least 1/16-inch using a chipping hammer, chisel, or other mechanical method. Treat as in step a. If strong bubbles are formed, the entire surface must be prepared by scarifying or other mechanical means. Subsequent chemical etching is not required. If there is no reaction, remove more concrete and repeat step a to determine the depth of hardening.

VI) Summary

The nature and degree of surface preparation required to achieve a sound floor substrate for application of a coating system depends upon the type and quality of the concrete, the presence of any surface treatments, the nature and length of exposure conditions, the type of protection desired, economics, and other considerations.

The end result must be a sound surface, which is cleaned and free of contaminants, which is absorbent enough to ensure good penetration by the coating, and which has a suitable profile. The only way to determine the most efficient and economical preparation method is to perform tests on the actual surface to be coated.

DRYWALL/GYPSUM

I) General

Recent years have witnessed rapidly increasing use of gypsum wallboard in building construction. Some people within the industry even refer to the swing to this modern, easily handled, quickly erected material as the “gypsum wallboard revolution.”

Several types of drywall originally had the attention of architects, builders and contractors. However, the preference for gypsum wallboard has grown continually. it is estimated that, today, more than 75% of all new residential buildings are finished with gypsum wallboard. Gains also are reported in the commercial and industrial fields where additional acceptance and application of the gypsum product is becoming evident.

Gypsum is a rocklike material found in generous supply around the world; some of the largest deposits are in the United States and Canada. Pure gypsum generally is colorless or white, although at times veins of tinted shades are unearthed. Made up basically of calcium sulfate, gypsum contains about 20% water.

Gypsum wallboard generally is produced with a gypsum core pressed between two strong, durable paper layers. The core is incombustible, the paper content negligible. Resistance to fire exposure depends only upon thickness of gypsum board used (usually available 1/4”, 3/8”, 1/2” and 5/8” thick) and the number of layers of boards.

Some manufacturers, with inclusion of other special ingredients such as vermiculite (made from a form of mica) and perlite (made from a volcanic glass) - with recommendations for inclusion of certain insulation in the stud space - are making possible easy completion of walls with 2 to 3 hours fire resistance, as well as others specially formulated for sound-deadening and insulating purposes.

Water resistant gypsum wallboard is a special grade produced for use in areas involving frequent contact with water, such as shower or tub stalls as a base for ceramic tile or other non-absorbent materials. Specially treated paper and a water resistant gypsum formulation are used in its manufacture. The facing paper is usually colored a light green to distinguish it from regular gypsum wallboard. To paint water-resistant wallboard, use a latex primer and latex or alkyd topcoats, or check with the manufacturer or supplier of this wallboard for their painting recommendations.

Use of gypsum wallboard was materially increased with development of modern reinforcing and concealing systems, which provide a completely smooth, seamless surface. Recessed edges permit the joints between the boards to be concealed by pressing a thin, strong tape into place over a special compound, with the tape then feathered to the surface level with the same compound.

Advocates of gypsum wallboard point out numerous advantages: the material is light, strong, flexible, easy to handle, easy to cut, quickly applied; it eliminates the moisture necessitated in plastering; it affords exceptional fire protection because its gypsum core will not burn or transfer heat in excess of 212° F until completely calcinated (a slow process by which water of crystallization is released as steam). It is not subject to attack by termites, other insects or rodents. Metal or wood trim may be installed almost immediately, and gypsum wallboard is ready to be painted as soon as concealing materials have dried.

II) New Surfaces

New gypsum wallboard surfaces normally need no special preparation before painting.

All surfaces should be dry and clean ... free of dust, dirt, powdery residue, grease, oil, wax or any other contaminants which may have accumulated or have been deposited accidentally upon the surface.

Joints between gypsum wallboard panels should be reinforced and carefully concealed during installation as instructed by the gypsum wallboard manufacturer and with materials recommended by that manufacturer. Fastener heads should be covered. Check to make certain that joint compounds and reinforcing tapes have been applied to provide a smooth, continuous, flat surface. Do not use linseed oil putty, glazing, patching pencils, caulking compounds or masking tape on gypsum wallboard surfaces to be painted. Sand and dust as necessary.

If, during cold weather, additional joint finishing is necessary, maintain temperature within the building between 55 and 70° F, as well as ventilation adequate to eliminate excessive moisture.

III) Previously Painted Surfaces

All previously painted gypsum wallboard surfaces should be completely dry, smooth-sanded, clean and free of dust, dirt, powdery residue, grease, oil, wax or any other contaminants such as flaking or peeling paint before paint application is started. All contaminants should be treated or removed. All defects should be corrected as necessary.

Dull glossy old paints by light sanding to assure maximum adhesion of the new coating. Patch holes and cracks with an appropriate patching compound. Sand smooth and spot prime with the paint or enamel to be used as the final coat.

INTERIOR PLASTER/GYPSUM

I) General

Plaster, long one of man's most popular building material, is said to have originated as the muddy binder for twigs and branches which some of our early ancestors put together for their shelters long ago. Through most of the last century, plaster basically has been made from a mixture of lime, sand, aggregate and water. At times, to add cohesiveness, quantities of vegetable or animal fibers were added to the mix.

More recently, the use of lime has declined in favor of gypsum. One of the greatest advantages of the gypsum plaster wall is its fire resistance rating of up to one full hour, although it also possesses the qualities of other plasters in structural strength, sound absorption, insulation and decorative values. While sand is still widely used as the aggregate, there is a constantly growing demand for use of lightweight aggregates - particularly vermiculite (made from a form of mica) and perlite (made from a volcanic glass). The advantages of gypsum plaster are light weight (one-third as much as sanded plaster) and even greater fire resistance than sanded plaster.

Today, fiber is rarely used in the plaster mix except at times in the first coat over metal lath - the sole purpose being to provide more body, to reduce the amount of plaster flowing through the mesh to be wasted on the floor. Gypsum plaster is produced from gypsum rock. Gypsum is basically calcium sulfate and contains 20.9% water by weight, chemically combined as water of crystallization. Gypsum is heated at high temperatures in a process known as calcination. Three-fourths of the water is driven off to produce Plaster of Paris, while one hundred percent water removal produces Keene's cement. Both are ingredients in gypsum plasters.

Today, gypsum plasters are used in more than 95% of interior plastering work. They set hard in two or three hours under normal conditions. If desired, such action can be delayed 24 hours or more by the addition of a retarder, or speeded up to as little as one or two minutes by the addition of an accelerator.

Plastering is accomplished by two basic methods - the three-coat application and the two-coat application. The former consists of the first binding coating known as the scratch coat, the second or brown coat, and the final or hard finish coat (also known as the white coat or putty coat). On the two-coat application, the scratch and brown coats are combined, the second coat being the hard finish. Plaster of Paris is generally used in gypsum plaster for the scratch and brown coats. Gauging plaster (special gypsum plaster mixed with lime putty) provides the most common putty coat or finish coat. Keene's cement is often used in mixing the finish coat because it sets very quickly in a hard, smooth, white finish, and dries faster than any other gypsum plaster. Properly formulated, Keene's cement plaster is stronger than putty coat plaster. Putty coat plaster is inherently weak as compared to thick, tough, highly cohesive paint films, such as the tile-like coatings. We do not, therefore, recommend using these types of paints over putty coat plaster. Use conventional paints over such surfaces or arrange for omission of the putty coat layer on new construction when use of tile-like coatings is anticipated.

Variations across the country in quality of water and sand, as well as difference in atmospheric humidity, have made it impossible to set standard plaster mixes for widespread use. Plaster applied to smooth; non-porous masonry surfaces can be troublesome because of poor bonding. Lath used under plaster may be plain or perforated gypsum board, wood or metal.

II) New Surfaces

New plaster surfaces should be allowed to dry thoroughly before application of any primers, sealers or paints. Seasoning of lime plaster (not used too widely today), prior to painting requires a minimum of from 30 to 60 days. Drying time for the more popular gypsum is considerably less, but will vary depending upon the mix and atmospheric conditions. When normal drying time cannot be allowed, it is necessary to use efficient artificial drying methods. This may be accomplished by using the building's heating system or by bringing in the necessary heater and blower equipment to provide free circulating warm or hot air.

Care must be taken also that new plaster is not dried too quickly. This can cause what is know as map-tracking or crazing, the appearance of small tracks or cracks running over the plaster surface, which may show through the paint finish. Dry-out is a condition of white spots appearing in plaster that is drying too fast. It happens in hot summer weather or can be caused by building overheating. "Sweat-out" is a result of too much moisture in the air; the plaster remains wet and fails to set. Under sweat-out conditions, new plaster will soon rot (indicated by dark color), which makes removal and replacement necessary.

In addition to being thoroughly dry before painting, new plaster also should be clean and free of dust, dirt, powdery residue, grease, oil, wax or any other contaminant accumulated since application. Wiping or dusting will often correct this condition. At times, it is advisable to sand smooth and level any rough spots or small plaster imperfections.

Perhaps most Important in choosing primers, sealers and paints for newly applied plaster is the necessity of recognizing that lime is present in the surface. Lime is alkaline. For best performance of the paint coatings, it is most logical to use alkali-resistant coatings for the first coat applied over bare plaster. Well suited for this purpose are the latex alkai resistant paints that many of which tolerate passage of excess water through their surfaces. They are often used as the entire coating system on plaster surfaces. A special latex primer with exceptional alkali resistance is ideal for sealing "hot" plaster.

III) Previously Painted Surfaces

Previously painted plaster surfaces should be dry, clean and free of dust, dirt, powder residue, grease, oil, wax or any other contaminants; free of flaking, crumbling or chalking conditions before paint application is started. All contaminants should be treated or removed. All defects should be corrected as necessary. Dull glossy old paints by light sanding to assure maximum adhesion of the new coating. Remove any loose, chipped, peeling or blistered old paint by scraping and smooth sanding. Patch holes and cracks with an appropriate patching compound. Examine side areas of holes and cracks. Remove plaster as far back as necessary to reach firm areas. Wet the open areas thoroughly several times before applying the patching material. After drying of patched areas, sand smooth and spot prime patched areas with an appropriate primer sealer.

FERROUS METAL/IRON & STEEL

I) General

Iron and steel are the most commonly used construction metals for reasons of strength, hardness, durability and moderate costs. Major limitations of iron and steel are weight (compared to aluminum) and vulnerability to corrosion and rusting.

Rusting, a process of disintegration of metal may be prevented by the use of paints and coatings systems to protect investment and to maintain appearance. A brief discussion of the rusting processes of iron and steel of various types is given here, which should lead to a better understanding of the need for meticulous surface preparation and coatings application to achieve maximum protection at the lowest cost.

Metal is referred to as "iron" when it contains pure iron and is not alloyed with other metals. "Steel" is basic iron alloyed with other elements such as carbon or small amounts of silicon as in common grades of steel. "Alloys" are special steels modified appreciably with other metals such as chromium, vanadium or molybdenum, incorporated to improve performance properties above the levels of iron or common steel.

The performance of paints and coatings, in addition to being affected by the composition of metal, may also be affected by metal producing processes such as cold rolling, hot rolling, casting and forging. "Cold Rolled" steel is rolled at room temperature into smooth sheets. Contaminants are not created by this process (other than oil or grease deposits). "Hot Rolled" steel is sheeted at extremely high (near fluid) temperatures for quick forming, with the resulting formation of a film of magnetic iron oxide called "mill scale" which should be removed prior to painting. Articles made of cast iron or cast steel in irregular shapes are developed by molding (casting) molten metal. Molding processes may create porous or roughly textured surfaces but do not create harmful contaminants. "Forged" steel is that which, in a solid state, is hammered into the desired form. Hot forging processes may create mill scale.

II) Surface Preparation Methods

Surface preparation methods must remove any contaminant that will interfere with the full development of adhesion of protective paint and coatings systems. Procedures are chosen depending upon the type and concentration of contaminants and the specific requirements of the protective coatings being used. Some coatings adhere properly only when surface "anchor patterns" are developed by sandblasting.

For optimum adhesion (mechanical bonding) an anchor pattern of between one and two mils in depth is required. Certain high build coatings may require a deeper pattern. Anchor pattern development is controlled mainly in the selection of the sand, grit and pressure used. Many coatings will perform satisfactorily over a lesser anchor pattern, but "critical" materials such as inorganic zinc will have poor adhesion to surfaces having an anchor pattern less than one mil in depth.

Special attention should be devoted to the thorough cleaning of difficult areas like joints and rivet heads, and to the removal of weld spatter and the soluble salts deposited by welding flux.

1) Water Washing - This method is used for removing water-soluble chemicals or foreign materials. Care must be taken to prevent extended contact of the water with the iron or steel surface since this may result in rust formation.

2) Steam Cleaning - Steam cleaning is usually accomplished with a "steam Jenny". The "Jenny" may use steam alone or in combination with cleaning compounds or detergents. Cleaning compound residue should be rinsed from the surface with water following steam cleaning. Steam cleaning is effective for removing oils, greases, and various water-soluble chemicals.

3) Weathering - Natural weathering is often used as one of the most economical methods of removing mill scale, dislodging it by the development of rust. Negatively, poor appearance prevails during the weathering period and heavy rust must be removed before applying finishes.

4) Solvent Cleaning (SSPC-SP1) - Solvents such as water, mineral spirits, xylol, toluol, etc. are used to remove solvent-soluble foreign matter from the surface of ferrous metal. Rags and solvents must be replenished frequently to avoid spreading the contaminant rather than removing it. Low-pressure (1500-4000 psi) high volume (3-5 gal. /min.) water washing with appropriate cleaning chemicals is a recognized "solvent cleaning" method. All surfaces should be cleaned per this specification prior to using hand tools or blast equipment.

5) Flame Cleaning (SSPC-SP4) - Flame cleaning is often used to dislodge foreign particles or mill scale on the surface of hot rolled steel. Due to differences in expansion and contraction of the mill scale as compared to the steel substrate, the mill scale is broken loose by playing a very hot flame over the surface.

6) Acid Cleaning or "Pickling" (SSPC-SP8) - This type of surface preparation is usually done in shops, not in the field. Acid cleaning, properly controlled, will remove mill scale and foreign materials while producing a very fine anchor pattern. Thorough rinsing of the surface after pickling is necessary to remove all traces of the acid, the presence of which may adversely affect the adhesion and performance of protective coatings.

7) Hand Tool Cleaning (SSPC-SP2), (SSI-St2) - This is a mechanical method of surface preparation involving wire brushing, scraping, chipping and sanding. It is not the most desirable method of surface preparation, but can be used for mild exposure conditions. Optimum performances of protective coatings systems should not be expected when hand tool cleaning is employed.

8) Power Tool Cleaning (SSPC-SP3), (SSI-St3) - This mechanical method of surface preparation is widely used in industry and involving the use of power sanders or wire brushes, power chipping hammers, abrasive grinding wheels, needle guns, etc. Although usually more effective than hand tool cleaning, it is not considered adequate for use under severe exposure conditions or for immersion applications.

9) Power Tool Cleaning To Bare Metal (SSPC-SP11) - This type of surface preparation utilize the same equipment as Power Tool Cleaning to remove all visible coatings and contaminants to bare metal substrate.

10) Sandblasting - Sandblasting is the process of projecting particles of sand, grit, or softer materials such as walnut shells against the surface at high velocity by means of a stream of air or liquid. If round particles are projected, such as glass beads or metal shot, the process is referred to as "shot blasting" rather than sandblasting, and the surface will develop a peened appearance. If the particles are relatively soft, such as nutshells or corncobs, the surface produced will be smooth and largely free of irregularities or anchor pattern.

If water rather than air is used as the propelling medium, the process is often referred to as wet blasting. In such instances, a rust inhibitive material should be used to prevent rust formation. Contaminants other than rust or mill scale should be removed prior to sandblasting to prevent further imbedment.

The Steel Structures Painting Council (SSPC) has defined various degrees of sandblasting in the following numerical specifications. Visual standards (Swedish Standards) in the form of Color photographs of steel panels with varying degrees of rust, corrosion and pitting which have been blasted to various specifications are available from the Steel Structures Painting Council or from the American Society for Testing Materials.

- **White Metal Blasting (SSPC-SP5), (SSI-Sa3) or (NACE #1)**
  The removal of all visible rust, mill scale. paint and contaminants, leaving the metal uniformly white or grey in appearance. This is the ultimate in blast cleaning and is used where maximum performance of protective coatings is necessary due to exceptionally severe conditions such as constant immersion in water or liquid chemicals.
- **Near White Blast (SSPC-SP10), (SSI-Sa21/2) or (NACE #2)**
  In this method, all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matters have been completely removed from the surface by abrasive blasting - except for very light shadows, very slight streaks or slight discoloration caused by rust stain, mill scale oxides or slight tight residues of paint or coating. At least 95% of each square inch of the surface area is free of all visible residues, and the remainder shall be limited to light discoloration mentioned above. Used when protective coatings will be exposed under conditions of high humidity, chemical atmosphere, marine exposures, etc. Practically, this is probably the best quality surface preparation that can be expected today for plant facility maintenance work.
- **Commercial Blast (SSPC-SP6), (SSI-Sa2) or (NACE #3)**
  This economical degree of blast cleaning is most commonly used. All oil, grease, dirt, rust scale and foreign matters are completely removed from the surface. All rust, mill scale and old paint are completely removed by abrasive blasting except for slight shadows, streaks or discoloration caused by rust rain, mill scale oxides or slight, tight residues of paint or coating that may remain. If the surface is pitted, slight residues of rust or paint may be found in the bottom of pits. At least two-thirds per square inch of the surface area shall be free of all visible residues and the remainder shall be limited to the mentioned light residues. This surface preparation method is used for moderate exposure conditions. Not intended for the conditions outlined in the preceding two methods.
- **Brush-Off-Blast (SSPC-SP7), (SSI-Sa1) or (NACE #4)**
  A method in which all oil, grease, dirt, rust scale, loose mill scale, loose rust and loose paint or coatings are removed completely. Tight mill scale and tightly adhered rust, paint and coatings are permitted to remain. However, all mill scale and rust must have been exposed to the abrasive blast pattern sufficiently to expose numerous flecks of the underlying metal fairly uniformly distributed over the entire surface. It is the most economical of the blast cleaning specifications and intended for ordinary exposures.
- **High and Ultra-High Pressure Water Jet Cleaning (SSPC-SP12) or (NACE #5)**
  As part of the surface preparation, deposits of oil, grease and foreign matters must be removed by ultra-high pressure water jetting, by steam cleaning with detergent or by the SSPC-SP1 methods. The difference in degrees of surface cleanliness is defined by the amount of pressure as follows:
  Low Pressure Water Cleaning (LPWC) - 34Mpa - 5,000 psi
  High Pressure Water Cleaning (HPWC) - 34 to 70 Mpa - 5,000 to 10,000 psi
  High Pressure Water Jetting (HPWJ) - 70 to 170 Mpa - 10,000 to 25,000 psi
  Ultra-High Pressure Water Jetting (UHPWJ) - Above 170 Mpa - 25,000 psi

III) Previously Painted Surfaces

Please refer to product specification. The performance of a new coating applied over previously painted surfaces is directly influenced by the type, age and condition of the old coating. If more than 25% of the previous coating has failed, it should be removed completely. If the previous coating can be easily scraped off from the surface, it should be completely removed also.
Hard or glossy paints should be dulled by sanding, sandblasting or other abrasive methods to assure maximum adhesion.

GALVANIZED METAL

I) General

Galvanized metal is a ferrous metal (iron and steel) which has been coated with zinc metal to prevent the formation of rust. Zinc metal is used for two major reasons - it provides physical protection as a coating while preventing rust by creating a protective chemical reaction.

When water and air contact bare ferrous metal, microscopic particles of iron (ions) go into solution and react chemically to form iron hydroxides and iron oxides known as rust. Intact galvanized coatings eliminate rusting by preventing water and air from reaching bare metal. Also, when galvanized coatings are ruptured by scratching, gouging or erosion allowing water and air to contact bare metal and adjacent galvanizing, a protective chemical reaction begins. Zinc, being more "active" than steel, goes into solution, (zinc ions) forming zinc hydroxides and carbonates, thereby offsetting the corrosive processes. This planned and continuous wearing of the galvanized surface is known as "sacrificial action". Since zinc is readily attacked by strong acids or alkalis, galvanizing is most effective in "near-neutral" (pH-7) environments.

Several methods are used for the production of galvanized metal. Among the more common are hot dipped galvanizing, in which, the ferrous metal part is immersed in a bath of molten zinc and then withdrawn, and continuous strip galvanizing, in which sheet or strip ferrous metal is drawn through molten zinc. Hot dipping is usually used for single or irregularly shaped pieces, while the continuous strip process is usually used to produce galvanized metal in coil or sheet form.

When zinc metal is given atmospheric exposure, a thin, dense, tightly adherent layer of zinc oxidation products normally forms on the surface. Under moist or humid conditions, however, especially if ventilation is poor, a more powdery material known as "white rust" or "damp storage staining" may form instead. Metal in coil or sheet form (usually continuous strip galvanized) is particularly susceptible, and most metal of this type is given a surface treatment by the manufacturer to minimize white rust. Chromate solutions are often utilized, but oils, greases, waxes, silicones, or silicates can also be used. All of these treatments may be detrimental to maximum paint adhesion.

Other surface treatments, usually employing acidic phosphate solutions, can be used to convert the surface of the galvanized metal to a thin layer of zinc salt crystals. This roughens the surface and improves the adhesion of subsequently applied paint films. Metal treated in this way is often termed "paintable". Such surfaces still require the use of a coating formulated for use over bare galvanized metal. If a coating cannot be applied to untreated galvanized metal, it should not be applied to "paintable" galvanized.

When painting galvanized metal, consideration must be given to the fact that zinc is being painted, not iron or steel. Coatings based on drying oils such as most oil and alkyd types tend to form acids on aging. Although they have good adhesion initially, such coatings may lose adhesion as the acids form within the aging film. These acids attack the zinc metal at the interface between the coating and the zinc metal to form zinc soaps, resulting in loss of adhesion and peeling of the paint film. Accordingly, special products are required for priming galvanized metal that do not form acids on aging, or are formulated in such a way that the acids formed may never reach the interface of the coating and the zinc metal.

II) New Surfaces

New galvanized surfaces must be clean, dry and free of contaminants. Oils, greases, waxes etc. can be removed by solvent cleaning in accordance with SSPC-SP1.

Removal of chromate or silicate treatments requires abrasive methods such as sanding or brush sandblasting.

Water-soluble contaminants should be rinsed off with water. In general, the proper surface preparation method will depend upon both the type of galvanized being painted and the type of coating being applied. If possible, the metal supplier should be consulted and the supplier's recommendations should be used in conjunction with information present on the selected coating's Product Data Sheet.

Exterior weathering will remove oils and many surface treatments and will provide a finely etched surface, which forms a good substrate for suitable paints. Weathering is unpredictable, however, being dependent upon the climate and the physical orientation and exposure of the galvanized surface. If used, it should proceed for at least six months, and the surface must be thoroughly examined prior to painting to make sure that it is clean and that the oxidized surface layer is uniform and tightly adherent.

III) Previously Painted Surfaces

If the previous coating on the galvanized metal is tightly adhered and in good condition (free of cracking, checking and peeling), it can be treated as any previously painted metal surface. The surface should be clean, dry and free of contaminants. Water-soluble contaminants should be removed with water. Mineral spirits or xylene should be used to remove oils, grease, waxes etc. Wiping cloths used in such an operation should be changed frequently to avoid redeposit of the contaminant.

If the surface is hard and glossy, it should be sanded lightly. In case of extreme hardness, brush sandblasting may be required to reduce the gloss and insure adhesion.

If portions of the previously painted surface have peeled and are devoid of paint, they should be treated as new surfaces and cleaned and spot-primed as prescribed under "New Surfaces". Rusted areas resulting from the loss of galvanized zinc due to long exposure or corrosive environment should be treated as bare, rusty steel.

ALUMINUM

I) General

Aluminum and aluminum alloys are widely used as materials of construction. Aluminum articles may be produced from aluminum foil, form sheets, extrusions, machined parts or cast aluminum. Aluminum products are light in weight and high in strength based on the weight used. Pure aluminum is not a very hard metal, but many of the alloys are extremely hard.

Aluminum has the advantage over iron or steel of not forming a colored rust or corrosion film on the surface when exposed to air. It does, however, form a thin, tightly adherent film of aluminum oxide on such exposure. This film is transparent and almost invisible and tends to prevent further oxidation of the aluminum. Chemicals, which attack or dissolve this thin aluminum oxide film thereby expose fresh aluminum and increase the corrosion rate of the aluminum.

Aluminum is readily attacked by either acid or alkali. If used or exposed under conditions where these materials or fumes from these materials come in contact with the metal, aluminum will be rapidly pitted or corroded. Aluminum used in such exposures should always be protected by a suitable coating.

A wide variety of alloys which combines such metals as copper, magnesium, manganese, silicon etc, which aluminum are produced for numerous special applications. Special grades of aluminum are available for marine use, use in aircraft, for improved machinability and for armor plate. Many aluminum articles are supplied with the surface pretreated chemically.
These pretreatment may be for the purpose of color or appearance, inhibiting corrosion or improving adhesion of coatings to be applied. Generally speaking, they do not adversely affect adhesion of paint to the aluminum, and in may instances actually improve it.

II) New Surfaces

Aluminum is not difficult to paint and accepts a wide variety of surface finishes. Oils and lubricants are often used in the fabricating or machining of aluminum and must be removed prior to painting. This can be achieved with solvents such as mineral spirits or xylol. On exterior products, it can also be accomplished by weathering for a month to six weeks prior to the application of paint. Dirt, water-soluble chemicals and similar surface contamination can be removed by washing with water or water and a detergent. If a detergent is employed, a final rinse with clear water should be made and the surface allowed to dry prior to the application of coatings.

Since aluminum does not have mill scale and usually does not accumulate heavy deposits of oxide, as can occur with iron and steel, sandblasting is infrequently used in the preparation of aluminum surfaces for painting. The thin oxide film normally found on the surface, or limited quantities of corrosion products are usually removed by power cleaning or hand cleaning such as sanding or scraping.

Most primers used on iron or steel will adhere properly to aluminum and can be used as the prime coat. Some alloys of aluminum, when exposed to high humidity conditions or to immersion will tend to pit if primed with coatings containing rust inhibitive lead pigments. Zinc chromate pigmented primers are very effective on aluminum products and are widely recommended for application as primers. In instances of moderate exposure conditions, topcoat may be applied directly to the aluminum without a primer and additional protection can be achieved by applying a second topcoat.

III) Previously Painted Surfaces

All chipped, peeling or blistered paint should be removed by hand tool or power tool cleaning. All oil, grease, dirt or other foreign materials should be removed from the surface in the same manner as described above under "New Surfaces." Any excessive chalking can be removed from the old paint by sanding. Remove any mildew present by scrubbing with a solution of one tablespoon of dry powdered laundry detergent and one quart of hypo-chloride type household bleach to three quarts of warm water. After scrubbing, rinse thoroughly with water. Wear protective glasses and rubber gloves to avoid eye and skin irritation. Allow to dry before painting.

WOOD

I) General

For centuries, wood has been a favorite structural material. In recent years marked advances have been made in preparing it for the new expanding lines of more easily applied longer lasting coatings. With proper surface preparation, wood can give greater beauty and protection than ever before. Achieving these objectives can be facilitated through awareness of the characteristics of wood.

Wood is generally classified as "hard" or "Soft". Hardwood comes from deciduous trees (broad leaf variety) such as oak and maple. Softwood comes from coniferous trees (needle shaped leaves or cones) such as cedar or pine. The "growth rings" that show in a tree trunk cross-section indicate not only the tree's age, but also have a bearing upon the dimensional stability of the wood. The lighter, wider bands are spring growth, or "early wood", while darker, narrower bands are summer growth, or "late wood". These late wood bands, being denser than early wood, are more difficult to finish because they provide less adhesion for paint and are subject to greater dimensional change during changes in moisture.

The method by which wood is cut into boards varies the position of these bands and influences the dimensional stability of the board and surface grain patterns.

Condition of the lumber is an important first consideration in selecting a coating. Fresh cut lumber has a high moisture content and must be seasoned by air or kiln drying. Lumber that has not been properly seasoned can warp and change dimensionally, providing a poor surface for the application of coatings. Air-dried lumber will average about 12 to 18 percent moisture and kiln dried lumber will average about 6 to 12 percent moisture. Some types of lumber, prior to marketing, are treated with materials such as creosote, pentachlorophenol, metallic naphthenates or water-soluble wood preservatives to prevent decay, mildew or attack by insects. Some of these treatments may adversely affect coatings and must be taken into account in order to obtain the best results from the coating.

As a general rule, smooth-sanded lumber is best for maximum coating performance. Rough or textured wood surfaces may be given special treatment to help achieve proper coating performance. The following procedures are based on years of experience with wood where coatings are involved.

II) New Surfaces

Wood should be clean, smooth, dried and free of oil, grease and dirt prior to the application of paint. Small amounts of oil or grease on the wood surface can be removed with mineral spirits. Defects such as knots, resins, gum pockets or extractives can be sealed with a mixture of equal parts of shellac and alcohol.

Remove mildew by scrubbing with a solution of one tablespoon of dry powdered laundry detergent and one part of hypochloride type household bleach to three quarts of warm water. After scrubbing, rinse thoroughly with water. Wear protective glasses and rubber gloves to avoid eye and skin irritation.

Nail holes, cracks and other defects in the surface of the lumber should be filled with caulking compound and/or putty prior to the application of paint.

Back priming of the wood prior to installation on a structure is an excellent procedure whenever feasible - it helps materially to prevent entrance of moisture into the back of the lumber with resultant paint failure. This is particularly true of lumber used for trim, which frequently presents cracks and openings that permits entrance of moisture. Openings permitting ingress of moisture should be caulked.

Redwood or red cedar, which contain natural water-soluble dyes, should receive two coats of an acrylic stain blocking primer or solvent thinned primer prior to application of a latex paint.

Creosote and colored metallic naphthenates bleed though most paints. If these have been used to treat lumber, they must be weathered off the surface prior to the application of paint.

III) Plywood Surfaces

The wood primer used should be applied as recommended, taking care not to build up thick surface films. Allow the primer to dry fully. Prime exposed ends of plywood but do not work excessive amounts of primer into spacing.

IV) Previously Painted Surfaces

Painted surfaces in good condition must be free of dirt, mildew, loose paint etc. Excessive chalking or dirt may be removed by washing with water. Hard glossy surfaces should be lightly sanded. Structural weaknesses should be repaired and openings permitting entrance of water should be caulked prior to repainting. Surfaces in poor condition should be prepared for repainting by removing loose paint and blisters by scraping, sanding or burning. Paint in these areas should be removed about 12 inches beyond the failing area. Prime before applying finish coats.

NOTE -Latex finish coating systems are a wise choice under these conditions since they allow reasonable amounts of moisture to escape through the film without deterioration of the film. Where coating exhibits failure over 25% or more of the surface, complete removal is recommended. The surface should then be treated as new wood.