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Decorative And Protective Coatings Guide

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

1. No matter how good the coating, its effective service life can be shortened by insufficient or ineffective surface preparation.
2. 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.
3. 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.
4. Obviously, a properly selected coating system will outlast an improperly selected system under the same conditions.
5. 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.

1. **Limitations:** **(Surface Preparation)**
   - Proper surface preparation is essential for the success of any protective coating scheme.
   - The importance of removing oil, grease, old coatings and surface contaminants (such as mill scale and rust on steel and zinc salts on galvanized surfaces) cannot be over emphasized.
   - The performance of any paint coating is directly dependent upon the correct and thorough preparation of the surface prior to coating.
   - Even the most expensive and technologically advanced coating system will fail if the surface preparation is incorrect or incomplete.

1.1. Steel: Surface Evaluation

The performance of protective coatings applied to steel is significantly affected by the condition of the substrate immediately prior to painting. The principal factors affecting performance are:

- Surface contamination including salts, oils, grease, drilling and cutting compounds
- Rust and mill scale
- Surface profile

The main objectives of surface preparation are to ensure that all contamination is removed, a surface profile created that allows satisfactory adhesion of the coating to be applied and to reduce the possibility of corrosion initiating from the presence of any surface contaminants.

1.2. Surface Contamination

It is essential to remove all soluble salts, oil, grease, drilling and cutting compounds and other surface contaminants prior to further surface preparation or painting of the steel.
Perhaps the most common method is by solvent washing, followed by wiping dry with clean rags.
The wiping is critical, because if this is not carried out thoroughly the result of solvent washing will simply be to spread the contamination over a wider area. Rags should be changed frequently.
Proprietary emulsions, degreasing compounds and steam cleaning are also commonly used.

1.3. Surface Imperfections

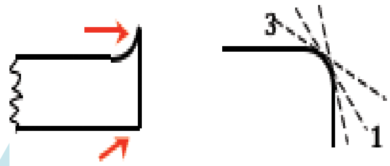
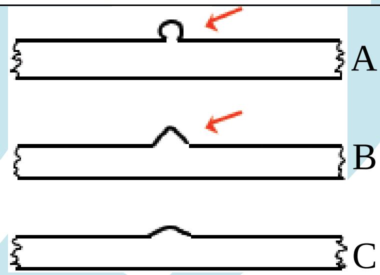
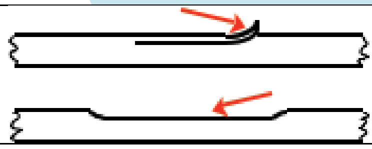
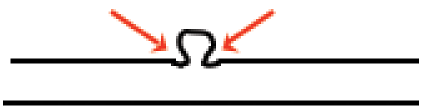
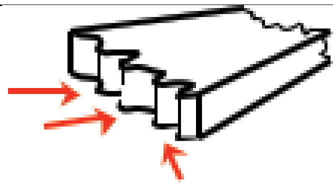
Imperfections on the substrate should be rectified prior to coating. Such corrections form part of the surface preparation process that should always be carried out before coating application.
Mill scale: A layer of ferric oxide formed on the surface of steel during hot rolling. Adherent mill scale should be removed by abrasive blasting or power tool cleaning. Hand and power tool methods can be effective on loosely adherent mill scale.

1.4. Existing coatings:

Removal by abrasive blasting is most effective; hand and power tool cleaning methods are also possible but much more labor intensive and best suited to small areas.

1.5. Rust:

Should ideally be removed by abrasive blasting prior to coating but the extent of removal required will depend on the coating system to be applied.
Hand and power tool methods are also possible but again, are more labor intensive and best suited to small areas.
If allowed to remain, loosely adhering mill scale, paint or rust can cause delamination of the coating from the substrate.

SHARP EDGE	Edges should be treated to a rounded radius of minimum 2mm, or subjected to three pass grinding or equivalent.	
WELD SPATTER	1. Remove spatter observed before blasting by grinder, chipping hammer etc. 2. For spatter observed after blasting: A) Remove with chipping hammer / scraper etc. B) Where spatter is sharp, use disc sander or grinder until obtuse C) Obtuse spatter – no treatment required	
PLATE LAMINAT ION	Any lamination to be removed by grinder or disc sander	
UNDERCUT	Where undercut is to a depth exceeding 1mm and a width smaller than the depth, repair by welding or grinding may be necessary	
MANUAL WELD	For welding bead with surface irregularity or with excessive sharp edges, remove by disc sander or grinder	
GAS CUT SURFACE	For surfaces of excessive irregularity, remove by disc sander or grinder	

2. Surface Preparation Methods:

A. Concrete

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 cleaner.

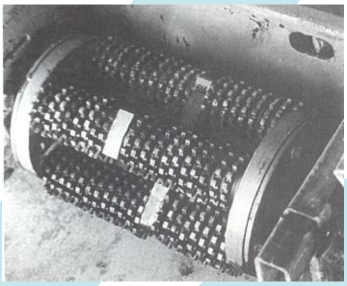
2) Acid Etching - The objective of acid etching is to dissolve the weak surface layer known as laitance and open the pores to allow penetration of the sealer coat.
   - A solution of muriatic acid is usually used.
   - The required strength will vary from 2% to 20% depending on the type of concrete mix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

B. Ferrous Metal/ Iron & Steel

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.

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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.

10-1) 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.

10-2) 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.

10-3) 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.

10-4) 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.

10-5) 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

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3. Limitations: (Application)

3.1. Application limitation:

- The object in applying a coating is to provide a film which will give protection and/or decoration to the surface being painted.
- The success of any paint application will be governed by a number of parameters, including:
  - Surface preparation
  - Film thickness
  - Methods of application
  - Conditions during application
- The importance of surface preparation to the success of a coating system cannot be over emphasized.

3.2 *An adequateFilAmn T ahdeicknqueatss :*

film thickness is essential for the success of any coating

system. Under-application will generally result in premature failure. However, the old adage of "the more paint, the better" can be equally dangerous.

- The gross over-application of modern high technology coatings can lead either to solvent entrapment and subsequent loss of adhesion, or to splitting of primer coats.
- With the majority of coatings, the limits of acceptable dry film thickness allow for reasonable practical variation, but the specified film thickness should always be the target during application.
- The actual dry film thickness recommended for a particular surface will depend on the type of coating system being used and the nature of the surface.
- Recommended dry film thicknesses for individual products are given on the product data sheets.

3.3 Dry Film Thickness Measurement

If a coating is applied to a steel substrate, previously blast cleaned with

abrasive grit or shot, the measurement of its dry film thickness is more complicated than that of a coating applied to a smooth steel substrate.

- The measurement results are influenced by the profile of the abrasive blasted surfaces which changes from point to point, the construction of the measuring equipment, (e.g. size of the probe) and dry film thicknesses to be measured. Some variations exist in methods of DFT measurement; DFT gauges can be calibrated on smooth or blasted steel panels and a correction factor for surface profile may or may not be considered. ISO 2808:2007, ISO 19840:2004 and SSPC-PA2 are accepted standards for measuring DFT.
- The DFT is typically measured using a non-destructive magnetic gauge, which will give a value measured from the surface of the coating to the magnetic plane within the surface profile.

4. Types of surface to be painted

4.1. 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

- 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.
- 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.
- 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.
- 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.
- 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

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

- 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) 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 evaporating.
- 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.

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.
- 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.
- 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.

4.2. 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, and 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.
- 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 5, 10, 13 and 15 mm 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 100° C 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 13 and 21° C, 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.

4.3. 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.
- 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.
- Gauging plaster (special gypsum plaster mixed with lime putty) provides the most common putty coat or finish coat.
- Use conventional paints over 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 known 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 alkali 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.
- 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.

4.5. 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 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 30 cm beyond the failing area.
- Prime before applying finish coats.

4.6. Ferrous Metal /Iron and 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.

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4.6.1. 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.

4.6.2. 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 many 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 drying 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.

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.

5. Application:

I) General

- The method of application is largely dependent on the type of coating selected.
- The most widely used methods of applying protective coatings are brush, roller, conventional (air) spray, conventional (pressure pot) spray and airless spray.
- The advantages and disadvantages of these methods are briefly discussed below.
- Other, less widely used methods include trowel, putty knife.

II) Brush Application

- Brush application should always be undertaken using an appropriately sized, good quality synthetic or natural fibre brush compatible with the product being applied. This application technique is relatively slow and is generally used for coating small areas with decorative paints and for surface tolerant primers, where good penetration of rusty steel substrates is required.
- It is particularly suitable for the application of stripe coats and for coating complex areas where the use of spray methods would lead to considerable losses due to overspray and associated dry spray problems.

- Note that most high build coatings are designed for application by airless spray; high film build will generally not be achieved by brush application.
- In general, twice as many coats will have to be applied by brush to achieve a similar build when compared to airless spray.
- Brush application requires considerable care when applying non-convertible coatings over one another, e.g. chlorinated rubber over chlorinated rubber, or vinyl on top of vinyl.
- Brush application requires considerable care when applying non-convertible coatings over one another, e.g. chlorinated rubber over chlorinated rubber, or vinyl on top of vinyl.
- In these cases, the solvents in the wet coat readily redissolve the previously dry bottom coat.
- Even a mild degree of the brushing out normally given to topcoats will cause pick-up of the previous coat and result in a very poor finish.
- Even, light strokes should be used in these circumstances, covering a particular area with one or two brush strokes, and on no account working the bristles into the previous coat.

III) Roller Application

- Roller application is faster than brush on large, even surfaces and can be used for the application of most decorative paints.
- However, control of film thickness is not easily achieved. As with brush, high film build will generally not be attained.

- Care must be taken to choose the correct roller pile length, depending on the type of paint and degree of roughness of the surface.
- Typically, phenolic core rollers should be used fitted with a smooth to medium pile roller cover and the roller cover should be pre-washed to remove any loose fibres prior to use.

IV) Air Spray (Conventional)

- This is a widely accepted, rapid method of coating application in which paint is atomized by a low pressure air stream.

- Conventional air spray equipment is relatively simple and inexpensive, but it is essential to use the correct combination of air volume, air pressure and fluid flow to give good atomization and a paint film free from defects.

- If conventional spray application is not controlled correctly, large losses of paint can result from overspray and rebound from the surface, in addition to problems such as poor flow, sagging and pin holing.
- The major disadvantage of conventional air spray is that high build coatings can generally not be applied by this method, as most paints have to be thinned to a suitable viscosity for satisfactory atomization, and so lose their high build properties.

V) Air Spray (Pressure Pot)

- Pressure feed tanks or pressure pots are commonly used in association with low pressure air stream (conventional) spray guns, to provide a means of delivering paint at a regulated pressure from a tank, through a fluid hose to a spray gun.
- The equipment works as follows: A length of air hose from the compressed air supply is connected to an air pressure regulator on the tank lid.
- Some air bleeds through the regulator at an adjusted pressure into the tank but most of the air passes the regulator and reaches the spray gun through a second length of air hose to atomize the paint as it is sprayed.

- The air which has entered the tank forces paint from it to the gun through a length of fluid hose.
- Paint in the tank can be prevented from settling by means of an agitator driven by hand or by a compressed air motor.
- Air spray (pressure pot) is recommended in cases where large quantities of paint are to be applied, and their use instead of a suction or gravity feed cup attached to the gun significantly reduces waste time in constant refilling.
- This also enables the gun to be turned to any angle to coat objects effectively without spilling paint.
- Pressure feed tanks of up to 20 liters capacity can be used and allow ease of movement around the workplace.

VI) Airless Spray

- Here atomization is achieved by hydraulic pressure forcing the paint through specially designed nozzles or tips.
- No air is mixed with the paint.
- The required hydraulic pressure is usually generated by an air powered pump having a high ratio of fluid pressure to air input pressure.

- Pumps with ratios between 20:1 and 60:1 are available, with perhaps the most common being around 45:1.
- The chief advantages of airless spray are:
  - High build coatings can be applied without thinning
  - Very rapid application is possible, giving an economic advantage
  - Compared to conventional spray, overspray and bounce-back are reduced, leading to reduced losses of material and lower fume hazards.
- The tips through which the paint is forced to achieve atomization are precisely constructed from tungsten carbide.
- The atomized fan is produced by a slot ground onto the face of the orifice.
- Various orifice sizes together with different slots angles are available.
- The choice of tip is governed by the fluid pressure required to give atomization coupled with the orifice size needed to give the correct fluid delivery rate.
- The fluid delivery rate controls the film thickness applied.
- Different slot angles produce spray fans of different widths.
- The selection of a particular fan width depends on the shape and size of the structure to be painted.
- Choice of fan width is also related to orifice size - for the same orifice size, the wider the spray fan the less paint will be applied per unit area.
- Airless spray equipment normally operates at fluid line pressures up to 352kg/cm^2 (5,000 p.s.i.), and should always be used in accordance with the manufacturer's operating instructions and safety precautions.
- Generally tips with an orifice size 0.23-0.33mm are suitable for coatings to be applied at approximately 50 microns wet film thickness.
- Tip sizes from 0.33-0.48mm are suitable for wet films of 100-200 microns and 0.48-0.79mm for 200 microns and above.
- Heavy duty mastics which are applied at very high film thicknesses may need tips with orifices as large as 1.02-1.52mm.
- There are several designs of tip available, the choice of which depends upon the finish required, the ease of application and ease of clearing blockages from the tips. With some products, the decorative effect achieved with airless spray is not as good as can be achieved by conventional spray.
- However, airless spray application is now widely accepted as a convenient method of applying high performance protective coatings.
- When applying protective coatings, the most important factors to consider are the condition of the substrate, the surface temperature, and the atmospheric conditions at the time of painting.
- Paint application should only be carried out when good atmospheric conditions and clement weather prevail.
- Painting should not be undertaken:
  - When the air temperature falls below the lower drying or curing limit of the coating
  - During fog or mist conditions or when rain or snow is imminent
  - When the surface to be painted is wet with condensation or when condensation can occur during the initial drying period of the paint

- During the night steel temperatures fall.
- They rise again during the day but there is always a lag in movement of steel temperature compared to the atmospheric condition, so condensation on the steel surface is possible.
- Condensation will occur if the steel temperature is below the dew point of the atmosphere.

VII) Borderline Conditions

- Bad weather is a familiar problem to those using protective coatings.
- Relative humidity itself rarely creates a problem.
- Most paints will tolerate high humidities, but humidity should not be permitted to lead to condensation on the surface being painted.
- In order to determine whether or not a surface is wet, the steel temperature should be measured using a surface temperature thermometer and the dew point calculated after measurement of humidity with a hygrometer.
- Paint application should not take place when steel temperature is less than 3°C above the dew point.
- Paint should not be applied when surfaces are affected by rain or ice.
- Some two pack paints (certain traditional two component epoxy coatings for example) should not be applied at low temperatures as curing may be retarded.

VIII) Extreme Conditions

- Generally, extreme conditions refer to ambient temperatures below 4°C or above 40°C.
- Below 4°C the curing of coatings such as traditional two component epoxies slows down dramatically and for some paints curing stops altogether.
- Water borne paints must not be stored or applied at temperatures below 4°C as application and performance properties will be adversely affected.
- Other protective coatings are not so severely affected.
- Chlorinated rubbers and vinyl's are quite suitable for use at temperatures below 0°C provided that the surface is clean and free from ice or frost.
- Some other coatings may also be applied at such low temperatures although curing will be severely retarded.
- At the other extreme of 40°C and above, the drying and curing of paints is rather rapid and care should be taken to avoid dry spray.
- This is caused by the too rapid loss of solvent from paint droplets between the spray nozzle and the surface. It can be avoided by:
    - Keeping the spray gun at the minimum suitable distance from the work piece, spraying consistently at 90° to the surface being painted
    - Adding thinners, if necessary, up to a maximum of 5% by volume
- In such conditions, techniques must be adapted this way to prevent defects such as voids, pinholes, bubbles and poor coverage due to the over rapid evaporation of solvent.
- However, provided that good standards of workmanship are maintained, it is normally possible to satisfactorily apply most International Protective Coatings products on to steel substrates up to 65°C.