

Draft Indian Standard

**CODE OF PRACTICE FOR PAINTING OF NON-FERROUS
METALS IN BUILDINGS**

PART I PRETREATMENT

(Second Reprint JUNE 1990)

0. FOREWORD

This Indian Standard was adopted by the Indian Standards Institution on ,16 October 1968, after the draft finalized by the Painting, Varnishing and Allied Finishes Sectional Committee had been approved by the Civil Engineering Division Council.

This standard is the first part of the Indian Standard code of practice for painting of non-ferrous metals in buildings, and deals with pretreatment of non-ferrous metals in buildings before painting. The second part of this standard covers painting schedules. Both the parts together are intended to provide guidance with regard to the painting of non-ferrous metals in buildings.

The increasing importance and use of non-ferrous metals as structural materials in a variety of conditions and environments had led to an increase in the forms which require painting. Zinc, copper and lead, when used in sheet form for roof covering are rarely painted and in other forms, such as pipes or fittings the areas to be painted are small. The development and extension of the use of non-ferrous metals in the form of claddings and linings for frame buildings and in light gauge sections as structural members call for an appreciation of their painting requirements. Zinc, copper, lead, pure aluminium and some aluminium alloys require painting only when in contact with corrosive materials or atmospheres or for decoration.

The original bright metallic appearance of the non-ferrous metals may be preserved by use of clear finishes, but frequent renewal and maintenance of the coating is necessary.

There has also been an increase in the use of non-ferrous metals, particularly zinc and aluminium, applied in various ways as protective coating on steel. If unpainted, such metallic coatings afford protection to the steel under most conditions, for periods related to the thickness applied. If properly painted and adequately maintained even greater protection is conferred.

Zinc in sheet form or galvanized steel, when new, always requires degreasing before painting; and to ensure adequate adhesion of the paint film the surface should be modified by pretreatment, or by about three months weathering in a clean atmosphere or as an alternative, a special primer may be used.

In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country. This has been met by referring to B.S. CP 231 :1966 'Painting of buildings' published by the British Standards Institution.

This standard is one of a series of Indian Standards on painting in buildings.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of

significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Draft Indian Standard

**CODE OF PRACTICE FOR PAINTING OF NON-FERROUS
IN BUILDINGS METALS**

PART I PRETREATMENT

1. SCOPE

1.1 This standard (Part I) covers pretreatment of non-ferrous metals in buildings before painting.

2. TERMINOLOGY

2.1 For the purpose of this standard definition of terms relating to painting shall be as given in IS : 1303-1963†.

3. NECESSARY INFORMATION

3.1 For efficient planning and execution of painting work with non-ferrous metals, detailed data and information as given below shall be taken into account:

- a) Nature of the metal or alloy to be painted;
- b) The condition of the metal surface and the presence of harmful materials on it (scale, rust, moisture, greasy dirt, salts, etc.);
- c) Environments in which the paint coating will have to function; and
- d) Information on the nature of previous finish is desirable for repainting during maintenance.

4. DESIGN CONSIDERATIONS

4.1 Designing should be done in such a way as to render the surfaces to be accessible and suitable for priming and to afford the maximum protection throughout the life of the paint.

4.1.1 Contact faces of metal should be suitably welded or brazed or adequately bedded with suitable gap-filling jointing compound. Buried or hidden faces should be protected from corrosion by priming and applying a further coat of protective paint. Sharp edges shall be slightly rounded to avoid paint receding from them.

4.1.2 In joinery exposed to outdoor conditions all tenons and other concealed areas should be primed before assembly. Door post, sash frames and similar joinery should be adequately primed all over, taking special care to prime any cut surfaces before fixing.

5. SUBSTRATES

5.1 General – It is most important that any substrate, whether it has been painted previously or not, should be in a fit condition to receive paint. To be ready for painting, a surface should be clean, dry and sound, and it should, as far as possible, also have reached a stable state.

5.2 Non-ferrous metals under normal conditions. of exposure are much less readily corroded than iron or steel; they are, in fact, often used on this ground and, although in some instances it may be preferred to regard these metals as sufficiently resistant to corrosion and avoid the cost of painting, under conditions of exposure to acidic or marine atmospheres it is essential to protect them from attack. Many of the non-ferrous metals present difficulty in painting because of their tendency to react with the paint, giving rise to poor adhesion, discoloration and poor drying, and it is necessary to take care to prepare the surface correctly and to employ painting systems which are not adversely affected.

5.2.1 Aluminium, zinc, cadmium, copper, lead, terne plate, 'magnesium and tin are susceptible in varying degrees to attack of alkaline building materials, for example, concrete, lime mortar and brickwork, especially under damp conditions and, when they are brought into permanent contact, an alkali-resistant coating for example, bitumen based paints should be applied preferably to both contacting surfaces.

5.2.2 Where aluminium, zinc, cadmium, copper, lead, terne plate, tin and magnesium are in contact with acidic hardwoods, such as oak and chestnut they will be subjected to attack unless adequately protected. Adequate precautions should be taken if these metals are placed so that rain water flows on to them from adjacent wood.

5.2.3 If the metal surface is damp or contaminated with acids or salts at the time of painting the metal may be slowly attacked beneath the paint film with the evolution of hydrogen which will cause blistering and stripping of the paint film; chemical pretreatment of the metal, helps to prevent this. It is, therefore, essential with magnesium, aluminium and zinc that the surface should be clean and dry at the time of painting.

5.2.4 In places where there is metal-to-metal joint, corrosion may occur under damp conditions. Where the metals are dissimilar the risk due to corrosion is greatest because of the electro-chemical reaction. Copper, nickel and their alloys are especially dangerous with non-ferrous metals like aluminium and zinc and should be avoided. Whether or not the metals are dissimilar, it is advisable to treat all surfaces to be joined with a jointing compound. Where joints are soldered, welded or brazed, care should be taken to remove fluxing materials before painting.

5.2.5 Zinc and aluminium are used singly or combined for protection of steel. Under normal conditions both metals will corrode more slowly than the steel they protect, and

their corrosion products will be less un-sightly than iron rust. They are both anodic to the steel and zinc will give a measure of protection even where the metal coating is disrupted.

5.2.6 The properties of non-ferrous metals applied as protective coatings to the more corrodible iron and steel are somewhat modified from the properties of the same metal in massive-form. For example, a sprayed metal coating is porous and rough, and its requirements both as regards its preparatory and priming treatment may be different from the solid sheet metal. In general, the conditions under which the non-ferrous metal is to be left unpainted are more restricted in the cases where the metal is used as a protective coating than when it is used in sheet or cast form.

5.3 Aluminium and Aluminium Alloys (Including Aluminium Coating on Steel) –

Under conditions of exposure in clean atmospheres, aluminium and its alloys will form a protective oxide film. In some situations the oxide film will provide sufficient protection to the metal without painting, but painting will be necessary if the change of appearance which accompanies the formation of the oxide film is unacceptable. In polluted atmospheres the various alloys of aluminium differ considerably in their susceptibility to corrosion and some are very inferior in this respect; in general, exposure to acids, caustic alkalies and salts, especially chlorides, are to be regarded as detrimental to the metal. For all these reasons, in industrial and marine atmospheres or whenever the metal is likely to be exposed to corrosive agents, painting will be necessary. In situations where the metal is exposed frequently or for long periods to damp conditions, such as the undersides of roofing sheets exposed to humid conditions protective treatment may be required.

5.4 Zinc, Including Galvanized and Other Zinc-Coated Steel –

In clean atmospheres it may not be necessary to paint zinc or galvanized steel except for decoration, although it may be preferable to paint the sprayed metal coatings. In damp and polluted atmospheres the rate of corrosion will be appreciable and exposure to acids, caustic alkalies or salts should be regarded as detrimental to the metal. Hence, in industrial or marine atmospheres or whenever, the metal is likely to be exposed to corrosive conditions, protection by painting will be necessary. The life of unpainted zinc coatings on steel in a given situation will be proportional to the weight of the zinc coating. Some guidance as to the corrosive nature of the local atmosphere in the past may be obtained by examining specimens of zinc coated steel which have been used in the immediate neighbourhood. If the galvanized coating which is proposed to be painted whether previously painted or not, has been allowed to deteriorate to such an extent that iron rust is beginning to form, it is essential to clean down thoroughly any corroded area of steel to bright metal and apply a suitable primer of a corrosion inhibiting nature.

5.5 Cadmium Coated Steel - The metal cadmium is somewhat reactive, and it may be pretreated before painting.

5.6 Copper and Copper Alloys – Difficulty in painting copper and copper alloys arises from chemical reaction between the metal and the drying oil used in the paint, and also

from the fact that the polished surface offers a poor key for paint. This may be overcome by the use of an etch primer which will both Seal the metal, preventing interference with the drying of any subsequent coats of paint and at the same time secure their good adhesion. Care should be taken to remove the copper dust formed on the surface where an abrasive has been used in preparing the surface, and to see that none remains on neighbouring paint work or masonry, since otherwise there is a risk of stains developing owing to the formation of verdigris. Where factory preparation is possible, an electro-deposited coating of tin is useful in preparation for painting.

5.7 Lead – Lead possesses good weathering properties and normally need only be painted for decorative purposes. New lead surfaces do not offer a good key for paint but, like zinc, they hold paint much better after a period of weathering. On new lead surfaces it is often advantageous to use an etch primer. Paint on lead tends to embrittle through interaction between metal and the paint, with the lead acting as additional driers, so that pretreatment of the surface and correct selection of primer is necessary to ensure satisfactory results should be avoided. Primer paints containing graphite as pigment.

5.8 Lead-Tin (Terne Plate) – As terne plate holds paint well, no special restrictions are necessary except that graphite shall be avoided in the primer. Where difficulty in painting is experienced in a particular environment, an etching treatment may prove beneficial.

5.9 Tin – Depositions of tin take paint very well. Attention shall be given to degreasing and roughening the surfaces in order to obtain good adhesion.

5.10 Magnesium and Its Alloys – The painting requirements of magnesium and its alloys are, in many respects, no more difficult than those of many other metals, and conventional paint systems may be used provided good painting practice is followed. Magnesium is a highly reactive metal and the oxidation product is alkaline. These features require attention for obtaining the best results from painting.

5.10.1 In clean indoor atmospheres, magnesium and its alloys corrode more slowly than iron and steel, becoming coated with an adherent white film and in clean outdoor atmospheres, a similar film forms more quickly. In acidic atmospheres or where it is in contact with metallic salts, especially chlorides, such as those in sea water, magnesium is attacked very rapidly. Although compared with aluminium, it is relatively resistant to attack by alkalis, it is generally advisable and sometimes essential to protect the metal either by painting alone or, preferably, by painting in conjunction with chemical pretreatment of the metal surface.

5.10.2 Painting problems may arise because of the development of alkaline reaction products formed by the moisture which penetrates the paint film. It is not therefore sufficient to neutralize the alkalinity of the metal before commencement of painting, for the alkalis condition will recur, but best results are likely to be obtained on these metals with paint films which are more resistant to the passage of water.

6.0 SURFACE PREPARATION AND PRETREATMENT

Surface preparation is the process of treating the surface of a material before applying coatings or adhesives, or before welding or assembly. It involves techniques like mechanical abrasives, chemical treatments, and laser technology. Surface preparation of aluminium is essential if the coating scheme applied is to perform well. Aluminium naturally has an attractive surface and superior corrosion resistance. Various surface treatments can enhance these characteristics or provide additional characteristics. Typical aluminium surface treatment methods include anodic oxide coating, coloration, coating, mechanical surface treatment, chemical film coating (Gloss treatment), enamel coating and plating. In addition, new technologies have been developed including ion plating and sputtering.

These methods of surface preparation ensure optimal adhesion and enhance material properties. Surface preparation involves the following steps :

- i). Remove surface contaminants and coatings
- ii). Increase the surface roughness
- iii). Modify the Chemical composition
- iv). Remove Abrasive dust
- v). Rinse off chemicals

i). Remove surface contaminants and coatings : The presence of contaminants on a surface can compromise the quality and effectiveness of various processes, including coatings, adhesives, and welding. To ensure successful outcomes and strong connections, it is essential to remove contaminants such as dirt, dust, rust, grease, and oil before any of these applications. Methods like laser cleaning, abrasive blasting , and chemical cleaning can be used to remove contaminants and obtain a clean surface.

Removing contaminants for coatings and adhesives : When contaminants are present on a surface, they create a barrier between the surface and the coating or adhesive. This results in inadequate bonding, leading to coatings that peel off or adhesives that don't hold as intended. Removing contaminants is crucial to ensure a strong and lasting bond.

Removing contaminants for welding : Contaminants and coatings on surfaces being welded end up inside the welds and can have multiple negative effects:

- Poor Fusion
- High Porosity
- Low strength

ii). Increase the surface roughness : Sanding, laser texturing and chemical etching can be used to roughen surfaces. While increasing roughness is not always necessary, it helps coatings and adhesives adhere better to surfaces.

iii). Modify the chemical composition : The chemical composition of a surface determines its interaction with other materials. By changing it better bonding capabilities can be obtained. Methods like laser texturing and chemical treatments can introduce oxides that improve bonding.

iv). Remove abrasive dust : When abrasives such as sandpaper, sandblasting and grinding wheels are used to prepare surfaces, they generate dust and loose particles that remain on the prepared surface. These contaminants must be removed so they don't affect the quality of the bond. This can be done using methods such as air blowing, brushing and solvent cleaning.

v). Rinse off chemicals : Chemicals used for surface preparation often play a crucial role in altering the surfaces chemical composition. But chemical residues (such as solvents or detergents) are contaminants that can interfere with the subsequent coating and bonding processes. Properly removing these residues is essential. For this reason, additional rinsing steps are often required when using chemicals. The resulting wastewater needs to be treated and disposed of properly.

Methods of surface preparation :

- i). Mechanical abrasives
- ii). Chemical treatments
- iii). Laser surface treatments

i). Mechanical abrasives : Mechanical abrasives include methods like abrasive blast cleaning, grinding wheels and wire brushes. These methods are cheap can remove tough and thick contaminants and can process large surfaces quickly. However, they require high maintenance, are imprecise, generate lots of dust and can damage the substrate.

ii). Chemical treatments : Chemical treatments often involve specific chemicals tailored to the material and the desired surface properties. They can be applied by immersion, spray, or manual application. These treatments include chromate conversion coating and phosphoric acid anodizing. Chemicals offer precise control and can create uniform surfaces.

However, they are hazardous for the environment and require strict safety measures. In addition, they may slow down the manufacturing process. This is due to the longer processing times and the need for thorough rinsing to remove residues.

iii). Laser surface treatments : Laser surface treatments include laser cleaning and laser texturing. As non-contact processes, these methods generate no mechanical wear and hence little maintenance. With their high precision, they can be used to prepare specific areas without affecting other areas. They are not ideal to remove thick coatings, clear coats, mill scale or to process large surfaces.

6.1 Pretreatment and priming of non-ferrous metals under controlled conditions at the factory gives the best results and it is, therefore, advisable to adopt this method

whenever possible. The object of such treatment is to preserve and maintain the metal surface during transport, storage, and erection and to minimize the 'on site' preparation for final painting. Much will depend upon the time between the factory treatment and erection, the care with which the materials have been stored and handled during that period and the protective quality of the treatment applied.

6.1.1 Application of a suitable priming coat should follow pretreatment without delay. Subsequent coats of paint may be applied on the site after cleaning down the primer and touching up with the primer paint any damaged parts.

6.1.2 Pretreatment processes are dealt with under two heads for different substrates:

- a) Factory pretreatment, and
- b) On-site pretreatment.

6.2 Aluminium and Alloys

6.2.1 *Factory Pretreatment* – This method covers the following:

- a) Mechanical surface treatment,
- b) Cleaning,
- c) Electrolytic or Chemical treatment, and
- d) Anodic treatments.

6.2.1.1 *Mechanical surface treatments* : Mechanical surface treatment produces a wide variety of cosmetic finish and textures. Various methods are used to achieve the finishes such as :

- i). *Buffing*
- ii). *Brushing*
- iii). *Bead blasting*
- iv). *Grinding*
- v). *Tumbling*
- vi). *Embossing*

i). Buffing : Buffing is usually a final process using abrasive or abrasive compounds that adhere loosely to a flexible backing, such as a cloth wheel. Buffing is used to generate extremely fine surfaces that match those associated with honing and lapping. A buffed surface is typically smooth, highly reflective and mirror like.

ii). Brushing : Brushed surface finish is a precise and versatile that enhances the aesthetics and functionality of non-ferrous products. The process involves using abrasive brushes or pads to create parallel lines on the surface, resulting in a method in which non-ferrous metal are finally sanded using light grade bristles or sand paper. *Hand or power wire brushing or other abrasive treatment* – This roughens the surface and mechanically improves the anchorage of paint films. The disadvantages are that

the natural oxide film on the metal is disrupted and oil or grease films and other foreign matter are not completely removed.

iii). Beed blasting : Beed blasting refers to the use of round spherical media that, when impacted against the surface of a part, will leave a more uniform finish caused by the sphere "dimpling" the surface.

This technique involves shooting small glass beads at high pressure onto the surface of the material, creating a uniform matt finish. It is used to quickly remove coatings or corrosion, clean up cosmetic defects, prepare surface for coatings.

Sand blasting – This should be carried out at relatively low pressures and with a fine silica sand. Where used, it should be followed by an inhibitive chemical treatment. It is typically more aggressive , can remove thicker coatings and surface contaminants and better suited for heavy duty applications. High pressure air is used to shoot abrasive particles at a high speed onto the aluminium surface to form fine pits and micro-undulations that increase the adhesion of the background metal.

iv). Grinding : Surface grinding is done on flat surfaces to produce a smooth finish. It is widely used abrasive machining process in which a spinning wheel covered in rough particles cuts-chips of no-metallic substance making it smooth/flat. The treatment leaves fine grooves in the direction of grinding. Surface textures can be made, very fine, medium or coarse.

v). Tumbling : A finishing operation that debrush,removes scratches and residues of aluminium. It also removes rust, cleans the aluminium and prepares the parts for further finishing. This process is accomplished by a large barrel being filled with parts which is then rotated and tumbled giving a matte to bright finish.

vi). Embossing : Embossing involves a tool pressing done onto the aluminium that creates a type of relief.

6.2.1.2 Cleaning : To increase the effectiveness of the finish, parts must be clean prior to coating. Various types of cleaning are as below :

Three types of cleaning are used for finishing :

- i). Solvent cleaning
- ii). Acid spray or immersion cleaning
- iii). Alkaline spray or immersion cleaning

Solvent cleaning – Solvent cleaning is generally the first surface preparation method applied to the aluminium. It removes release agents such as silicone etc. Solvent cleaning should both precede and follow abrasive treatments. Solvents such as methyl ethyl ketone, toluene, acetone isopropyl alcohol, trichloroethylene and perchloroethylene can be used. Substrates can be wiped or sprayed with degreasing solvents or they can be immersed in an agitated solution for about five minutes. Solvent

cleaners are usually used on small surface area and offer limited ability to remove difficult oils. Solvents usage is diminishing in favor of more environmentally friendly options. Solvent cleaning does not disturb the natural oxide film on the metal and may prove adequate for some applications, such as ambient indoor or very mild service conditions. Where possible, solvent cleaning should be followed by chemical treatment or anodic treatment (see **6.2.1.3** and **6.2.1.4**). Solvent cleaning includes methods such as

- Vapor degreasing,
 - Immersion or Spray Method
 - Aqueous/Mechanical/ ultrasonic scrubbing.
- Vapor degreasing: Vapor degreasing is the cleaning process which involves condensing solvents vapors on the object that is being cleaned. The process doesn't require any water or scrubbing . The whole cleaning process occurs in a machine chamber where a chemical solvent is vaporized inside, dissolving all oil and contaminants on the equipment's surface. Vapor degreasing method is preferred to ultrasonic method.

Benefits :

- Superior cleaning performance and effectiveness
 - No dependence on manual cleaning
 - Prevents cross-contamination
 - Repeatable
 - Quick, no extra drying process required
 - Recycle solvent from one part to another
- Immersion / Spray Method: Both acid and alkaline cleaning can be applied by immersion or spray. In both cases a multi-step water rinse follows the cleaning stage to thoroughly remove the cleaning solution from the aluminium surfaces. Immersion cleaning is an effective way to remove these contaminants. It involves submerging parts in cleaning chemistry and then agitating them to loosen and remove the dirt. These are systems with various cleaning mechanisms and stages with additional features depending on the application. Immersion cleaning is often used for objects that are difficult to clean with other methods. It can also be used for delicate items that cannot withstand scrubbing or abrasive cleaning agents. Immersion parts cleaning involves placing the parts into a basket and submerging it into a single or series of dip tank that contains a heated cleaning solution bath consisting of either a solvent or aqueous cleaning chemical.
- Aqueous/Mechanical/ ultrasonic scrubbing : The aqueous cleaning method uses water based solutions to clean industrial parts. Aqueous cleaning agents emulsify and encapsulate contaminants, so they can be easily removed. Aqueous cleaning has a reputation for being more environmentally friendly than solvent cleaning. Ultrasonic cleaning, also called aqueous cleaning, involves cleaning equipment by producing high-frequency sound waves in a water based solution. In contrast to vapor

cleaning, aqueous cleaning only has one tank containing a slow drying, nonflammable liquid, such as water, enhanced with detergent or saponifier. The cleaning process is short but does not eliminate all contamination from being cleaned. This type of system works by transferring high frequency sound waves through a liquid. The metal parts being submerged are then cleaned by the cavitation process. In this method as the bubble created and imploding on the metal surface and thus impurities and rust are removed.

Benefits :

- Little-to-no maintenance required
- Great for removing bonded contaminants
- High-pressure cleaning
- Ability to clean around bends and blind holes
- Only requires detergent and water

ii). Acid Spray or immersion cleaning : Acid based cleaners are used to remove inorganic deposits such as scaling. Using chemicals such as hydrochloric and sulphuric acids, the process of acid cleaning or also called pickling is processed on stainless steel, copper, brass, aluminium and precious metals.

This process is based on sulphuric or phosphoric acid solutions and surfactants. However, Hydrochloric acid is usually added as an activator. Typical acid cleaning operating temperature are in the range of 50-70 °C for contact times of 5-60 seconds. An acidic solution for use as an aluminium cleaning and brightening composition includes an aqueous solution of from about 1-15 weight percent hydrofluoric acid about 1-5 weight percent, sulphuric acid and about 1-5 weight percent phosphoric acid.

This process is used for:

- Deburring
- Removal of rust and corrosion and surface contaminants
- To provide a clean and uniform surface in preparation of other processes like painting, plating or welding.

iii). Alkaline Spray or immersion cleaning : Alkaline cleaning is a surface preparation operation utilizing an immersion of the workpiece into an alkaline aqueous solution (or spraying of the solution on the workpiece) where the contaminants such as mineral oils and grease etc are removed from the workpiece surface as a result of a combination of chemical and physical actions of the cleaning solutions. Alkaline cleaning processes are based on sodium hydroxide (NaOH) solutions. Typical operating temperatures are in the range of 50-70 °C for contact times of 5-20 seconds. It is a fast etching process compared to acid cleaning. However, solid precipitates form in the bath and waste (aluminium hydroxide) has to be managed. Some oxide particles and

intermetallics, which are insoluble in the alkaline solution, form a 'smut layer' which loosely attaches to the aluminium surfaces. As a result, alkaline cleaning must be followed by an acid de-smutting step.

The following methods may be employed:

- a) Manual scrubbing with mineral spirit or a high flash solvent naphtha. With this method it is extremely difficult to prevent accumulation of contaminants on the swab or in the solvent. This method is recommended when other treatments are impractical.
- b) Solvent spray cleaning.
- c) Vapour degreasing in special equipment employing solvents like trichloroethylene vapour.

Suitable alkaline cleaners free of caustic soda may be used hot (80-100°C) followed by thorough rinsing in water.

6.2.1.3 Chemical / Electrolytic treatments – Electrolytic treatment increases the cleaning power considerably. The mechanism and the process of electrolytic cleaning in these acids is similar to anodizing. For anodizing, the process generates the characteristic anodic oxide film with regular pore structure on the aluminium surface. The oxide film development is a competition between film growth and dissolution. By controlling acid concentration and temperature, it is possible to make the aluminium oxide dissolve at the same rate as it is formed. This is electrolytic cleaning. The electrolytic cleaning does not need HF which is good for health and safety and environment.

The aluminium surfaces should be freed of oil, grease or other foreign material by means of the procedure described in 6.2.1.2 (c) or (d) or any other suitable methods given below:

- a) *Alkaline etch – Alkaline etching is one of the most common surface pretreatments performed in order to prepare aluminium surfaces for the subsequent conversion coating, anodizing or general coating application. Cleaning is also often performed under mildly alkaline conditions. Alkaline etching is an important step in the anodizing pretreatment for aluminum alloys can effectively remove the dirt and natural oxide film on the matrix surface. Its purpose is mainly to provide smooth surface for distributing the current evenly and produce a uniform film in the anodization. Alkaline etch is basically cupric chloride with the copper complexed with ammonia to keep it in solution at a higher Ph. Etching aluminium in sodium hydroxide is by far the most common pretreatment for aluminium that is to be anodized. It imparts a matte finish to the end product. Alkaline etches are also used to strip off anodic coatings. However, under no circumstances should an etch only finish be used in a finish product because there is no way to prevent the rapid onset of corrosion. Alkaline solutions based on caustic soda etch the metal, thus destroying the natural oxide film. They are followed by an acid treatment,*

preferably nitric or phosphoric acid. These are not generally recommended unless followed by a conversion treatment.

- b) *Sulphuric-chromic acid etch* – This treatment produces a passive surface suitable for painting under mild exposure conditions and where clear finishes are to be applied. Chromic acid is also called Tetraoxochromic acid or chromic(VI) acid. It is usually a mixture made by adding concentrated sulphuric acid to a dichromate which consists of a variety of compounds and solid chromium trioxide.
- c) *Phosphoric acid cleaners* – These may be applied by swabbing or dipping at room temperature or hot followed by the rough rinsing with clean water. A very thin phosphate film is formed which tends to protect the metal and promote paint adhesion under mild exposure conditions. Phosphoric acid cleaner is a fast acting, easy to use acid base cleaner. It is used in metal rust proofing before painting, in the polishing of metals, in pickling and in hot stripping for aluminium and zinc substrates.
- d) *Acid fluoride deoxidizer* – This process uses nitric or sulphuric acid with chromic acid and a fluoride. It provides a clean and uniform surface. The deoxidizing solution is generally used at 35 to 55°C by immersion followed by a water rinse. Fluoride etches the surface of aluminium alloys. Hydrofluoric acid and salts are very powerful in the aluminium deoxidizing process as they improve the etch rate.
- e) *Crystalline phosphate treatment* – This consists of reacting the aluminium surface in a zinc-acid-phosphating solution to form a crystalline phosphate coating of the proper texture adopted to inhibit corrosion and increase the adherence and durability of any applied paint film. The phosphate process may be carried out by immersion or spray application.
- f) *Amorphous phosphate treatment* – This process comprises treatment of clean aluminium surfaces by immersion, spray or roll coat in aqueous solution containing phosphoric, chromic, hydrofluoric acids or solutions thereof. The aluminium surface is converted to a thin, adherent amorphous coating iridescent green to gray green in colour which inhibits corrosion and increases the adherence and durability of applied paint films. This method is recommended for use under the more severe conditions of service.
- g) *Carbonate chromate treatment* – This process comprises treatment in a hot dilute solution of sodium carbonate and potassium chromate followed by a water rinse. This forms a thin, adherent, conversion coating increasing the corrosion resistance of the metal and promoting paint adhesion.
- h) *Amorphous chromate treatment* – This comprises treatment in aqueous chromic acid solutions with fluoride containing accelerators. This surface is converted to an adherent, amorphous, mixed metallic oxide coating iridescent golden to light

brown in colour which increases the corrosion resistance and the adherence and the durability of any applied film. The coating process may be carried out by immersion, spray or roll-coat. It may be necessary to precede the treatment with a deoxidizer [see (d)].

- i) *Etching or wash primers* – This treatment is based on the deposition of an acid-bound resinous film on the aluminium surface in such a manner as to enhance the adhesion of subsequently applied paint coatings. The film may be applied by brush, spray or dip. The film has good adhesion to the metal substrate.

6.2.1.4 Anodic treatment – *Anodizing treatment involves electrolytic treatment of metals, during which stable films or coatings are formed on the surface of metals. Anodic coatings can be formed on aluminium alloys in a wide variety of electrolytes, using either alternating or direct current. This coating is usually a few microns thick and is made up of an oxide layer. Anodizing is used to improve the metal's durability, corrosion resistance and aesthetic quality. It is also used to give the metal a unique colour or finish. Anodic treatments in either chromic or sulphuric acid electrolyte will provide a protective and inert oxide coating which increases the corrosion resistance of the metal and promotes paint adhesion. It is recommended where maximum corrosion resistance is desired. Anodic treatments should not be used on assemblies of dissimilar metals.*

Materials and procedures employed in the methods of treatment given above are available from a number of sources as proprietary compounds or methods and where they are used, processes recommended by suppliers should be followed.

Process of Anodizing Treatment:

- *Sulphuric Acid Anodizing Process: This is one of the most popular methods of anodizing. Sulphuric acid anodizing is used to give aluminium and other metals a long-lasting, corrosion resistant finish. In order to form an oxide layer, the metal is immersed in a sulphuric acid bath while being electrically energized. A lubricant is then used seal this layer, giving it weather resistance and a glossy, smooth finish. Because of its accessibility and efficiency, sulphuric acid anodizing is preferred for numerous applications. It has a smooth, attractive appearance, superior electrical insulation and great corrosion resistance.*
- *Chromic Acid Anodizing Process: Chromic Acid Anodizing (CAA) is a type of anodizing process that uses chromic acid to create a protective layer on metal surfaces. Because of its ability to produce a range of hues, CAA is often employed to develop decorative finishes. In this method chromic acid electrolyte is used in place of sulphuric acid. Chromic trioxide and sulphuric acid are combined to form this solution, which is heated to a temperature of around 220 °F. Once the electrolyte solution is heated, the metal is submerged in the solution and an electrical current is applied. This causes the chromic acid to react with the metal, forming a protective oxide layer on the surface. The oxide layer is porous and can be coloured by adding dyes to the electrolyte solution. CAA is often to*

create a decorative finish, as it can produce a variety of colours. It also increases the corrosion resistance. This process is more expensive than other types of anodizing, but it produces a higher- quality finish.

- *Boric- Sulphuric Acid Anodizing Process (BSAA): BSAA is a type of anodizing that uses a combination of boric acid and sulphuric acid to create a strong, corrosion-resistant finish. It is more environmentally friendly alternative than other forms of anodizing. It takes two steps to anodize with BSAA. In the first step, boric acid and sulphuric acid are used to etch the metal surface, resulting in a porous surface. The anodizing solution mat permeate the metal more deeply and thus giving the metal a stronger and more durable polish. In the second step, the metal is subjected to a voltage, which causes the surface to become anodic and create a protective oxide layer. Because of its resistancw to corrosion and abrasion, this layer is perfect for usage in demanding conditions.*

Hardcoat Anodizing Process: The process of hardcoat anodizing, sometimes referred to as Type III anodizing, is used to give a thicker and harder coating. This kind of anodizing process strengthens the metal's wear resistance and offers excellent corrosion protection. In the hardcoat anodizing procedure, the metal is submerged in an electrolyte solution and electrical current is run through it. This results in a chemical reaction that coats the metal with a tough, protective coating. Hardcoat anodizing, also known as Type III anidizing, is a procedure used to give aluminium and other metals a thicker and harder finish. This kind of anodizing increases the metal's wear resistance and a high level of corrosion protection is offered. The metal is submerged in an electrolyte solution during the hardcoat anodizing process and then an electric current is run through it. As a result, the metal develops a tough, protective covering due to a chemical reaction.

6.2.2 On-Site Pretreatment

6.2.2.1 Details of surfaces untreated or protected with a temporary protective are given below:

- a) Temporary protective materials are often applied to aluminium sheet to protect it during storage, transport and erection. These materials should be removed with suitable solvent as a preliminary to other preparatory treatments.
- b) Lubricants used in the rolling of aluminium sheet may be particularly tenacious and may have undesirable effects on paint adhesion. The use of abrasive paper wetted with suitable solvent, is effective in removing the worst effects of these materials. Where joints are welded, soldered or brazed care should be taken to remove fluxing material before painting. This may be effected with a 10 percent aqueous solution of formic acid followed by thorough washing, or with suitable solvents.

- c) Surfaces which are protected with a temporary protective shall be treated by the use of wash or etching primers preceded, if necessary, by the removal of the temporary protective.
- d) In the case of heat hardened alloys the surface shall be treated by mechanical roughening combined with degreasing. Such work should be carried out as thoroughly as possible to ensure that the paint will adhere well and give protection and durability. The surface should be well scrubbed or swabbed with a suitable solvent, then abraded with abrasive paper and finally rinsed with successive portions of clean solvent on clean swabs. This method should not be used on composite sheets which depends on a very thin lining of pure aluminium for corrosion resistance.
- e) Proprietary compositions are designed to etch the surface after degreasing, but care should be taken unless the manufacturers specify otherwise, to remove all residues by washing before painting and also to ensure that the compositions do not contaminate other parts of the structure.
- f) Casting in aluminium alloys may often be painted without any pretreatment other than removal of grease. The surface usually provides a good key on sprayed aluminium coating usually without pretreatment.
- g) Where it is required to paint aluminium which has been left unpainted and which has acquired a surface layer of corrosion products, this layer shall be removed. Removal may be difficult if the corrosion is considerable. Mechanical means of removal include the use of stainless steel wire brushes, but ordinary steel wire brushes should not be used. The latter may leave embedded particles of steel which encourage further corrosion. If adequate safety precautions may be ensured, chemical removal may be adopted using special inhibited acid solution, but thorough subsequent rinsing and drying of the surface is essential.

6.2.2.2 Surfaces already factory pretreated and/or primed should be carefully inspected and damaged areas should be thoroughly degreased, by clean solvent swabbing, any corrosion products formed should be thoroughly removed and touched up with a coat of wash or etching primer or suitable chemical pretreatment solutions. The rectified, areas should then be brought forward with appropriate primer, putty, finish coats, etc.

6.3 Zinc

6.3.1 Sheet zinc and galvanized steel, when new, should be degreased before painting to ensure adequate adhesion of the paint film. Even when this is done the paint may adhere satisfactorily only if the surface is modified by chemical treatment or by the action of the weather, or if the recommended priming paints are used. This is because zinc may react with many types of conventional paint to form water sensitive, brittle compounds at the paint/metal interface and the various forms of preparatory treatment

prevent these interactions taking place. In some cases wash primers/calcium plumbate primer may be used without special surface treatments.

6.3.2 Factory Pretreatment – The surface should be freed of oil, grease or any foreign contaminant by means of the procedure described in solvent cleaning method (see **6.2.1.2**) before applying any of the treatments recommended below:

- a) *Crystalline zinc phosphating treatment* – Zinc phosphate is a crystalline conversion coating that is formed on a metal substrate utilizing the chemical reaction between metal ions that have been dissolved in mineral acids and then diluted with water to form the process solution. Phosphating is a chemical method of surface treatment in which a metallic surface reacts with an aqueous phosphate solution. Zinc phosphate pretreatment process converts the metal surface, the coating provides an excellent base for paint adhesion. As zinc phosphate conversion coatings incorporate additional metal ions into the coating to increase the alkaline resistance, it makes an excellent paint base offering superior adhesion and durability. The zinc phosphate pretreatment process is applied by either spray or immersion applications depending on the industry and can be used on a wide variety of substrate including steel, hot dipped and electrogalvanised, zinc nickel alloy and aluminium. The zinc surface is converted to a crystalline zinc phosphate to inhibit corrosion, increase adherence and durability of paint film. The treatment may be provided by dip, spray or brush application.
- b) *Chromate treatment* – Chromate conversion coating is employed to impart brightness and improve the corrosion resistance of bare metal and as a substrate to provide improved paint adherence on non ferrous surface. It can be used on aluminium, zinc, tin plate, copper, cadmium, magnesium and zinc plated surfaces. These coatings are achieved by immersion and electrochemical processes. Chromate treatment is a chemical process where a chromium compound solution is applied to a metal surface, to form a protective chemical coating of chromate. The chromate treatment process starts with degreasing, washing, etching and rinsing, to clean, roughen up and increase the metals surface area. The chromate treatment is then applied by spraying or immersion. This consists of a dip or spray with a dilute solution of a mixture of chromic and other acids to provide a thin amorphous chromate coating that increases corrosion resistance and paint adhesion.

Advantages of chromate treatment includes :

- Improved corrosion resistance due to the continuous coating which covers the metal surface and prevent direct contact with corrosive environment.
- Decorative features such as natural appearance, clear, light gold iridescence, golden brown etc.
- Provides an effective base for paints
- Good electrical conductivity

- c) *Aqueous chromic organic treatment* – *Chromic acid anodization was developed initially as a treatment to improve the corrosion resistance of aluminium surfaces from oxidation. The anodizing process build a basic oxide layer which supports a tubular cell structure. This structure is then generally sealed in hot water by conversion of the porous cell structure to the trihydrated aluminium oxide. This sealed oxide layer is thick, structurally weak and generally not satisfactory for adhesive bonding. By the addition of a small amount of chromic acid to the seal water a sealed anodized surface can be developed to which good bonds can be formed.* Certain water soluble resins with chromium compounds may be applied to zinc surfaces by roller coat or other suitable means, such as by dip or squeeze rolls. The resultant coating provides a corrosion resistant film that increases the adhesion of applied paint film.
- d) *Etching or wash primers* – This treatment should be carried out on the lines given in **6.2.1.3 (j)**.

6.3.3 On-Site Pretreatment

6.3.3.1 Surfaces untreated

- a) The surface should be thoroughly degreased by solvent wipe by applying the wash or etching primers.
- b) The surface should be thoroughly degreased by solvent wipe by applying an etching solution. Some of these are similar in action to the phosphating solutions mentioned above, while others are based on acids or other mordants. The use of mordants containing copper is not recommended since the last traces of copper, which are difficult to remove, stimulate corrosion. After using any etching solution the surface should be thoroughly rinsed with clean water to remove acids and salts, which might be deleterious if allowed to remain.
- c) If the zinc or galvanized steel is allowed to weather up till the bright spangles disappear before painting, it attains a condition suitable to receive paint without the necessity of degreasing or etching; it will be necessary, however, to- clean down to remove dirt, corrosion products, etc. Since the galvanizing alone, if of reasonable thickness is sufficient to protect the steel from corrosion for some years in normal atmospheres, the few months delay before painting is not likely to result in corrosion.
- d) An alternative process is to abrade the surface thoroughly with emery cloth lubricated with a suitable grease solvent to produce a uniform, fine matt surface, and subsequently wash with successive portions of clean solvent. The process is laborious and suitable only for small areas.

6.3.3.2 Surfaces already factory pretreated and/or primed – Such surfaces should be treated on the lines given in **6.2.2.2**.

6.4 Magnesium

6.4.1 Chemical pretreatment of the metal may not be done easily on the building site and it should, therefore, be carried out at the works before the metal parts are delivered.

6.4.2 *Factory Pretreatment – Magnesium is really not too difficult to paint. Degreasing, pretreated by deoxidizing and priming prior to painting, cleans it. Since magnesium is more alkali resistant than aluminium, it is degreased using strong alkaline cleaners. Deoxidizing can be done by acid pickling with chromic acid. Blast cleaning will also remove oxidation. It should be ensured that oily residues and corrosion causing contaminants are not driven into the magnesium surface. Surfaces should always be degreased before blast cleaning. Mechanical (abrasive) treatments, solvent cleaning, alkaline solution treatments, and acid pickles not resulting in protective conversion coatings are suitable preliminary treatments only for metal to be exposed under mildly corrosive (Indoor) conditions. When a high degree of corrosion protection and paint adhesion are desired, as in many outdoor environments, surface preparation by a suitable conversion coating treatment, such as the dichromate method shall be adopted. Certain anodic treatments simultaneously produce conversion coatings on, and remove contamination from, magnesium alloy & surfaces.*

6.4.2.1 Wash or etching primers may also be applied on previously cleaned surfaces. Etching primers are less efficacious on magnesium than on most other metals and special attention should be given to the risk of acid attack by the phosphoric acid, with hydrogen evolution, leading to bubbling and pinholing of the paint films. Best results may be obtained when the etching primer film has been stoved at low temperatures.

6.4.3 *On-Site Pretreatment – The most satisfactory method is to apply etching primer after degreasing the surface by a solvent cleaner or preferably an etch cleaner based on phosphoric acid. The combination of etching pretreatment and etch primer gives better results than if either were used alone.*

6.4.3.1 If the surface had already been factory treated and primed, application of further coats of paint should be followed in the usual manner after suitable rectification of damaged areas, if any.

6.5 Cadmium – Similar to zinc except that weathering is not required.

6.6 Copper and Copper Alloys – The surface should be thoroughly cleaned with an organic solvent and then roughened with fine abrasive paper and applied with one coat of etching primer. Firstly, it should be degreased and any dirt or old paint to be removed. This will ensure proper adhesion and the expected parameters of a new coating. Care should be taken to remove from the surface the copper dust thus formed and to see that none remains on neighbouring paintwork or masonry, since otherwise there is a risk of stains developing owing to the formation of verdigris. Where factory preparation is possible an electro-deposited coating of tin is useful in preparation for

painting. The process of removing old paint from copper can be tedious and depends on the type of preparation used. The following techniques should be used to clean copper :

- Sandblasting : This involves cleaning the surface with a jet of sand or other abrasive under high pressure. It is effective in removing rust, paint or organic contaminants, but it does not work well on delicate components.
- Chemical cleaning : Using special chemicals that react with contaminants and old paint to dissolve them.
- Electrochemical cleaning : This technique uses an electrolyte and an electric current to remove contaminants from the copper surface.
- Mechanical rubbing or grinding : For smaller components or delicate surfaces, mechanical cleaning methods such as scrubbing with a steel brush or sanding with sandpaper can be used. However, this method must be used very carefully to avoid damaging the surface of the copper component.
- Ultrasonic cleaning : This method involves immersing the copper component in a special chemical solution and subjecting it to ultrasonic treatment. It is effective in removing very fine contaminants but requires specialized equipment.

6.7 Lead – New lead surface should be weathered or pretreated before painting, the latter being preferable because of the inter-action between lead and many conventional paints. The application of etching primer is satisfactory as a pretreatment for bright lead. An alternative is to treat the surface with a diluted solution (about 20 percent by volume) of orthophosphoric acid followed by thorough washing and drying.

6.8 Lead-Tin (Including Terne Plate) – The main preparation required for these surfaces is thorough degreasing with white spirit or other suitable solvent, followed by a washing with hot water. An etching procedure which has been recommended where maximum adhesion is required is to swab with a solution of 5 parts concentrated hydrochloric acid in 95 parts methylated spirit until a crystalline pattern is seen (about 10 seconds) and washed in hot water.

6.9 Tin – The painting of tin applied by methods other than hot dipping present no difficulties, but adhesion may be defective on hot dipped coating, which should be roughened or treated with etch primer prior to painting.