Compendium
Of
Industrial Painting & Coating Processes
For
Machine Tools

Indian Machine Tool Manufacturers' Association

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Foreword

IMTMA is bringing out the 1st edition of "Guide Book on Industrial Painting & Coating Processes for Machine Tools" to strengthen the supply chain for the benefit of the Indian Machine Tool Industry.

This reference book will lay down the basics of paint applications, coating types and technologies, common paint problems with possible solutions relevant to the machine tool industry

The content of the manual is described from various related websites, manufacturers' guidelines and machine tool builders' feedback. Important topics are discussed and focused in order to enlighten the knowledge of industrial paints and coating processes.

Every effort has been made to make this handbook as 'complete and accurate as possible'. Nevertheless, it is likely that some aspects may not have found a place in this first edition. IMTMA would appreciate the feedback and suggestions from readers to incorporate in future editions. Any more information can be obtained from the websites mentioned in the concluding page of the manual.

Chapter 1 Basics of Paint on Machine Tool

1.1 Introduction

The purpose of paint on machine tool is two-fold. First it protects the metal surfaces from corrosion and second serves as décor to add to the appeal of the machine. We paint our machine tools for the same reasons that we paint our cars. We want them to look good and protect the metallic surface from corrosion. If we stick with the automobile analogy we can even look at the initial painting of the car before it leaves the factory and then at some later time when the car is older and needs maintenance painting. We, of course, see the same type of pattern with machine tools. When customer is buying a new machine the paint job is at least an indirect contributor to the decision and it should probably be one of the items on his quality check list.

A bad machine tool paint job not only causes the machine to look bad" before its time" but can cause machine function and parts quality problems. If the paint "sluffs off" or dissolves and is re-deposited on parts or the machine, it can cause cleaning problems or machine malfunction.

For many years the standard color for a machine tool was grey and although gray still is the predominant color, many other colors are now used. Industrial engineers assigned to plant layouts sometimes use colors to make the work environment more enjoyable for employees. They also color code the departments within the plant. Machine in one department may be blue and in another gray or green, etc. Paint manufacturers refer to this as color harmonics.

Chapter 2 Industrial Painting and Coating

2.1 Introduction

Paint usage has environmental impacts at all stages of its life cycle, including manufacturing, application, and eventual disposal. The purpose of this chapter is to provide general background information on environmental compliance requirements for painting application operations, with specific emphasis on minimizing wastes through pollution prevention. This chapter reviews various coating applications, coating types, pollution prevention opportunities, and environmental regulations.

General steps for painting and coating applications typically include the following:

- **Substrate Surface Preparation**
- **Application of the Coating**
- **Drying of the Coating**

Preparatory, application, and drying processes chosen depend on many factors, including clients' demands

2.2 Surface Preparation

Surface preparation of the material (substrate) to be painted is very important. As high as 80% or more of all coating adhesion failures can be directly attributed to improper surface preparation. A substrate must be clean before a coating is applied. Improper preparation can lead to a lower quality or defective product, or one that is not visually appealing. The most common forms of surface debris are oils or greases that originated from mechanical processing, or are deliberately applied for purposes of corrosion prevention during temporary storage or shipping. Other surface contaminants commonly include oxidation, rust, corrosion, heat scale, tarnish, and in some cases, old paint. Dirt, grease, or other similar materials will block the bonding surface and create an imperfection on the finished part. Proper preparation improves the bond between the coating material and the surface, and ensures the coating is applied and adheres in a uniform manner.

Examine your operations and see if there is a way to minimize the amount of cleaning required by keeping your substrate from getting dirty during storage or processing.

2.1.1 Methods of Cleaning

i. **Mechanical Cleaning**
ii. **Chemical-assisted Cleaning**
iii. **Conversion Coatings**

i) Mechanical Cleaning

The first step in your preparation process should be mechanical cleaning. Wiping loose dust and dirt off your parts with a rag is an easy example. More vigorous action may be needed to remove rust or other contaminants strongly attached to the part. For wood surfaces, sanding followed by wiping with a lint-free cloth is effective. For metal sub-strates, metal scale and rust can be removed by brushing the part with a wire brush, a sand or grit blaster, or plastic "wool" pads.

ii. Chemical-assisted Cleaning

Another option for preparing your parts for painting includes chemical-assisted cleaning. Traditionally, solvents have been used to remove oily type contaminants through wiping, spraying, dipping, or vapor degreasing. But there are problems associated with solvent cleaning. Spraying can be wasteful, dip tanks can lead to large quantities of hazardous waste being generated, and vapor degreasers are regulated under environmental laws and pose a potential health hazard. Also, solvent-contaminated rags may need to be disposed of as hazardous waste.

With such issues in mind, some have switched from solvent to aqueous cleaning, which is generally more environmentally friendly. Acidic solutions effectively remove rust, scale, and oxides from metal surfaces, but can cause hydrogen embrittlement as hydrogen gas formed penetrates the metal and reduces its strength. Mild alkaline solutions are used to clean and remove rust and scale from metal substrates because no hydrogen embrittlement results. Elevated temperature solutions are more effective for removing greases and oils, but the energy consumption needs to be considered.

iii. Conversion Coatings

For those working with metal substrates, a conversion coating may be applied to metal prior to painting to improve adhesion, corrosion resistance, and thermal compatibility. Conversion coatings chemically react with the metal surface to build a more complex physical surface that improves the bonding of the coating. Iron and zinc phosphate coatings are usually used for steel. Iron, zinc, and chromium phosphate are all used when it comes to coatings for aluminum, with the choice of solution largely depending on the volume of aluminum being processed.

2.2 Coating Applications

Which paint or coating application process you choose will depend on your particular operations. What is the material you are coating? What are the chemical and physical characteristics the coating must have? What is the shape and size of the product—does it have a unique shape that might make uniform application more difficult? How many products must you paint each shift?

Several factors affect how good the paint coverage is on the piece, as well as the transfer efficiency of the application. Transfer efficiency is the relationship between the amount of paint you apply and the amount of paint actually adhering to the part being coated. The higher the transfer efficiency of your process, the more paint you are getting on your part and the less overspray you have. Your equipment and booth setup, the type of paint you're applying, the particular product you're coating, and your painting operators' skill all factor into how efficiently you're using your paint.

Coatings consist of resins, pigments, solvents, and additives. Particular types of coatings you're applying will have varying amounts of each of these constituents. Resins or binders hold all paint constituents together and enable them to cure into a thin plastic film. Resins are made up of polymers, which are chosen based on physical and chemical properties desired in the finished product. Acrylics produce a shiny, hard finish with good chemical and weather resistance. Alkyds are relatively low in cost and because of their versatility are considered a "general purpose" paint. Epoxies provide excellent water resistance and superior chemical resistance, but do lose their gloss from ultraviolet light. Urethanes combine high gloss and flexibility with chemical stain resistance, and demonstrate excellent water resistance.

Pigments are tiny particles insoluble in paint incorporated to improve the physical appearance of the coating. Additives are also used to impart specific physical or chemical properties to the coating. Some pigments or additives may contain metals which may classify any resulting solid wastes as hazardous. Paint performance may be improved by adding curing agents, defoamers, gloss modifiers, or other agents.

Solvents are used to carry the coating solids to the part being painted. They are also added to paint to aid in its application by reducing viscosity so the coating may be easily applied. Solvents are a major source of environmental concern in coating applications because as curing occurs, hazardous air pollutants (HAPs) and volatile organic compounds (VOCs) are released.

Many of these same chemicals may cause any solid wastes generated as part of your painting operations to become hazardous wastes. Additionally, any discarded products may fall under the Resource Conservation and Recovery Act (RCRA), or hazardous waste regulations.

The next chapter goes into detail about different coating application types and technologies currently being used.

2.3 Drying and Curing

Getting the paint or coating to your product's surface is only half of the process—the other half being how the coating will be transformed into the hard, protective, decorative finish that your clients will desire. Will your paint dry by evaporation? Will drying outside your booth be necessary due to your choice of coatings or to your product schedule?

If the resin or binder is said to be convertible, then it undergoes some form of chemical reaction to transform it to the solid film. If the resin is non-convertible, then it is only the evaporation of the solvents in the paint that causes drying and results in the desired film. Some coatings are cured by a process that can be controlled, such as baking, providing an opportunity for overspray to be collected and recycled.

Chapter 3 Surface Preparation – A guide for the users

3.1 Introduction

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, laitence on concrete and zinc salts on galvanized surfaces) cannot be over emphasized.

This chapter gives a brief guidelines about the considerations that one needs to consider, prior the use of coating systems, in terms of surface preparation, international practices and related advices. And this guide could be a valuable tool towards to a successful application and the desired performance"

3.2 Surface Preparation

The effective lifetime of a coating applied on to a substrate depends to a large extent on how thoroughly the surface is prepared prior to painting. Most premature paint failures are attributed to improper surface preparation.

Surface preparation consists of primary surface preparation and secondary surface preparation. The primary surface preparation aims to remove mill scale, rust, corrosion products, and foreign matter from a steel surface prior to application of a shop-primer or paint.

The secondary surface preparation aims to remove rust and foreign matter, if any, from a steel surface that has been already coated with a shop-primer or paint, prior to application of anti-corrosive system. All rust, rust scale, heavy chalk or deteriorated coatings must be removed by a combination of solvent or detergent washing, hand or power tool cleaning or abrasive blasting. Glossy areas of sound previous coatings need not be removed but should be mechanically abraded or brush blasted to create a surface profile which increases coating adhesion.

3.2.1 Surface Preparation - Ferrous Substrate

Cleaning

Cleaning involves the cleaning of oil/grease, dirt, soil, salts and other contaminants from the surface of substrate by the use of solvents, solvent-vapour, alkali, emulsion or steam.

Hand Tool Cleaning

Hand tool cleaning is one of the oldest processes for preparing surfaces prior to painting. Hand tool cleaning is used only for removing loosely adhering paint or rust. The hand tools include scrappers, abrasive pads, chisels, knives and chipping hammers. The common processes of hand tool cleaning are -

Wire brushing

Wire brushing is a conventional method not suitable for the removal of mill scale, but suitable for the preparation of weld seams. The main disadvantage is that the treated surfaces are often not completely freed from corrosion products.

Chipping

Chipping is usually done in combination with wire brushing. It is suitable for local repairs with conventional or some specific paint systems. It is generally not recommended for preparation of surfaces to be coated with epoxy or chlorinated rubber paints. It is very useful in removing thick rust scale and economises in later blasting operations.

Power Tool Cleaning

Power tool cleaning involves pneumatic or electrically operated tools for cleaning operations.

It is very rapid compared to hand cleaning methods. It provides a duplication of hand tools in power driven equipment, such as sanders, grinders, wire brushes, chipping hammers, scalers, and needle guns.

Power tools used for cleaning of:

- **Impact cleaning tools**
- **Rotary cleaning tools**
- **Rotary impact cleaning tools**

Flame Cleaning

Flame cleaning involves de-rusting by use of high temperature flame (oxy-acetylene or propane and oxygen). It is very efficient in removing mill scale but removes rust to a lesser extent. This method is restricted because of safety hazards.

Water Jet Cleaning

Water jetting uses water of sufficient purity and quality at high or ultra high pressure to prepare a surface for recoating. It can be used to clean steel, non-ferrous metals and other hard surfaces. It generally removes loose paint, chemical contaminants, loose rust and scale, grease and other material not tightly bonded to the surface. Four types of surface preparations using water are given below:

- **Low pressure water cleaning: Cleaning performed at pressures less than 34 MPa(5000 p.s.i)**
- **High pressure water cleaning: Cleaning performed at pressures from 34 to 70 MPa (5,000 to 10,000 p.s.i)**
- **High pressure water jetting: Cleaning performed at pressures from 70 to 170 MPa (10,000 to 25,000 p.s.i)**
- **Ultra high pressure water jetting: Cleaning performed at pressures above 170 MPa (25,000 p.s.i)**

Water jet cleaning is very effective for cleaning irregularly shaped surfaces such as valves, flanges and gratings. Where abrasive blasting is not feasible water jet cleaning can be an effective alternative. Water jetting will not produce an etch or profile of the magnitude produced by abrasive blasting, rather, it exposes the original abrasive blasted surface profile.

Water jet cleaning can be destructive to non-metallic surfaces. Soft wood, insulation, electric installation and instrumentation must be protected from direct and indirect water jet. Water used in water jetting must be clean and free of erosive silts or other contaminants that damage pump valves or leave deposits on the surface being cleaned.

Abrasive Blast Cleaning

Abrasive blast cleaning involves the impingement of a high kinetic energy stream of abrasive (such as sand, grit or shot) onto the surface to be prepared. It may either be hand operated by jet or automatically by impeller and is the most effective method for removal of mill scale, rust and old coatings, but not oil or grease. Four common grades of blast cleaning are:

White metal blast cleaning: (Swedish standard - Sa 3)

A white metal blast cleaned surface when viewed without magnification, shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products and other foreign matter.

Near - white metal blast cleaning: (Swedish standard - Sa 2½)

A near-white metal blast cleaned surface when viewed without magnification, shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products and other foreign matter. Generally evenly dispersed very light shadows, streaks and discolouration caused by stains of rust, mill scale or previously applied paint/coating may remain on no more than 5% of the surface.

Commercial blast cleaning: (Swedish standard - Sa 2)

A commercial blast cleaned surface when viewed without magnification, shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products and other foreign matter. Generally evenly dispersed very light shadows, streaks and discolouration caused by stains of rust, mill scale or previously applied paint/coating may remain on not more than 33% of the surface. Slight residues of rust, paint/coating may also be left in the crater of pits, if the original surface is pitted.

Brush off blast cleaning: (Swedish standard - Sa 1)

Brush-off blast cleaned surface when viewed without magnification, shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products and other foreign matter. Tightly adherent mill scale, rust and old paint/coating may remain on the surface.

Wet Abrasive Blast Cleaning

Wet abrasive blasting may be performed with low or high pressure fresh water to which a relative small amount of abrasives is introduced, and in some cases inhibitors are added to prevent flash rusting (however, as a general rule it is recommended not to use inhibitors when cleaning areas are to be immersed during service).

This reduces the amount of airborne dust and sand. It is necessary to rinse the surface after blasting to remove sand and debris.

International Standards

Summary of International Standards of Blast Cleaning

Standards Cleaning Method	Swedish Standard	ISO Standard	SSPC Standard	NACE Standard
Hand tool cleaning	St 2	-	SSPC - Sp 2	-
Power tool cleaning	*St 3*	-	*SSPC - Sp 3*	-
White metal	*Sa 3*	Sa 3	SSPC - Sp 5	NACE - 1
Near white metal	Sa 2 1/2	Sa 2 1/2	SSPC - Sp 10	NACE - 2
Commercial blast	Sa 2	Sa 2	SSPC - Sp 6	NACE - 3
Brush-off blast	Sa 1	Sa 1	SSPC - Sp 7	NACE - 4

The standards given above give a visual impression of the quality of the de-rusted steel.

However, invisible contamination like soluble salts should also be absent. This should be checked by measuring the conductivity of water that has been used to wash a certain small area of a (blast) cleaned surface.

All standards of cleaning steel are based only on the cleanliness of the surface. When steel is polished and clean (having no anchor pattern) it is also Sa 2½ or Sa 3. Therefore, Sa 2½ or Sa 3 is not an indication of roughness. With all sorts of abrasives the grade Sa 2½ is reachable.

But each type of abrasive and the speed at which it makes contact with the steel gives a different anchor pattern.

As per ISO 8501-01, the initial condition of steel is given by the rust grades as given below:

A =Steel covered completely with adherent mill scale and with, if any, little rust.

B =Steel surface which has begun to rust and from which the mill scale has begun to flake.

C =Steel surface on which the mill scale has rusted away or from which it can be scrapped but with little pitting visible to the naked eye.

D =Steel surface on which the mill scale has rusted away and on which considerable pitting is visible to the naked eye.

For further details, please refer the specified standards.

3.3 Surface Profile

In addition to the cleaning requirement, a surface also must have sufficient profile (anchor pattern or tooth) to permit bonding of the primer. Abrasive blasting of steel generally provides an irregular profile, while mechanical tools frequently provide a burnished surface.

Surface profile indicates the roughness of blast cleaned surface. 'Surface profile is an independent factor' and it has no relation to the standard of cleanliness. The profile of roughness obtained during blasting is important and will depend upon the abrasive media, the air pressure, and technique of blasting.

To specify the roughness, a variety of values are used, such as Rz, Rt, Ra, C.L.A.
Rz = average peak to valley height = blasting profile
Rt = maximum peak to valley height
Ra = average distance to an imaginary center line which can be drawn between peaks and valleys
C.L.A. [Center line Average (ISO : 3274)]
Blasting Profile (Rz) = 4 to 6 times C.L.A. (Ra)

Generally the profile height of steel should be in between 1/2 and 2.5 mils and not more than one third of the total dry film thickness of the coating system.

Too high a profile will result in uneven coverage of high sharp peaks possibly leading to premature coating failure. Too low a profile may not provide a sufficient key of coating. For some product a minimum surface profile is mandatory as indicated in our product data sheet.

3.4 Surface Preparation - Non-Ferrous Substrate

Surface should be dry and clean. Any visible oil/grease should be removed. Cleaned surface should be abraded or sweep blasted using low pressure and non - metallic abrasives, then primed with a coat of etch primer.

Galvanized Steel

Degreasing to remove any oil/grease. Any white zinc corrosion products should be removed by high pressure fresh water washing or fresh water washing with scrubbing. Even if sweep blasting is done, water-washing is recommended to ensure removal of soluble zinc salts.

Stainless Steel

Stainless steel surface does not require any specialized surface pretreatment prior to coating. These surfaces should be free from oil, grease, dirt and other foreign materials

by chemical cleaning. The development of a surface profile on stainless steel is highly recommended to assure good coating adhesion. A profile depth of between 1.5 and 3.0 mils is suggested for most coating systems. Because stainless steel is a very hard metal, abrasive blasting is recommended to impart a continuous surface profile.

Concrete Surface

New concrete or masonry:

Must be allowed to cure at least 30 days before coating. The moisture content of the concrete/masonry should be less than 6%. In case of large areas and for severe exposure conditions, the surface has to be prepared by light blasting. In less critical areas where blasting is not practical, wire brushing has to be adopted to remove laitance, followed by treating with dilute hydrochloric acid (10%).

Old concrete surface:

Remove the surface contaminants like grease, oil, etc., by solvent wiping or by 10% caustic solution. Preferably the surface has to be prepared by light blasting. In case, blasting is not practical, etch the surface to get a good profile by treating white dilute hydrochloric acid (10%).

Remove acid and contaminants by liberal wash with water. Ensure that acid solution does not retain on the surface and joints. Allow the surface to dry thoroughly before applying primer. Any cracks should be cut out and filled with suitable filler prior to painting.

3.5 Paint Application

3.5.1 Application - Brush

Brushing is the most common method for applying coatings. While brushing is a somewhat slow procedure many small jobs do not warrant the use of any other application method. Brushing is especially useful for touch up work, spot priming, work in confined areas or where spraying is impossible. Less paint is wasted when applied by brush than by any other method.

Either natural or synthetic bristle brushes are suitable for use with "solvent based" coatings. Synthetic bristle brushes are preferred with "water based" coatings because natural bristles tend to swell in water.
Suggestions for good brush application:

- Use of high quality, clean brushes of the proper shape and size will help achieve the best application.
- Assure that all holidays or voids are eliminated, but avoid excessive brushing which may reduce film thickness and decrease protection.

- Avoid filling the heel of the brush with material. Approximately half of the bristle length of the brush should be wet.
- Stroke the brush at 45° angle. Light strokes at this angle ensure even flow.
- The brush application shall be by up and down strokes, then crosswise and finally with up and down strokes lightly. This is called cross lapping and helps eliminate brush and lap marks. Fast drying materials often do not permit cross lapping which may cause paint to pile up. If it is necessary to brush apply fast dry material, it should be flowed on rapidly and generously and then left undisturbed. To go back over such a surface usually results in excessive brush drag, leaving ridges and brush marks.

3.5.2 Application - Roller

Rollers are efficient tools for applying industrial coatings and are suited for broad flat surfaces. The general rule for selecting a roller cover is 'the smoother the surface the shorter the nap'. Solvent thinned coatings should be applied with either lamb's wool or synthetic covers and water reduced coatings should be applied with synthetic covers. When using rollers to apply coating systems such as epoxies and polyurethanes which contain strong solvents, be sure that the roller cover selected is constructed with glues which are resistant to these strong solvents.

Suggestions for effective roller application:

- On large areas, material should be applied approximately on 0.75 sq.m. at a time.
- Saturate the roller cover thoroughly with the coating. Paint should be loaded onto the cover until just before it drips.
- The first strokes with the loaded roller should be done in a "W" pattern within approximately 0.75 sq.m. area.
- The "W" pattern should then be fixed in with successive strokes.
- Work from dry areas back into wet areas. In this way a more uniform film thickness is maintained.
- When a material is applied to warm surfaces in direct sunlight or when fast drying coatings are used, work in smaller areas to maintain a wet edge.
- Most coatings will dry to a slight orange peel appearance when applied by rollers.

3.5.3 Application - Spray

Introduction

The easiest and most rapid method for the application of protective coatings to large areas is spraying. Spray application is preferred where a smooth uniform finish is desired and speed of production is important. Conventional air atomization is used when quality of finish is of utmost importance or where great versatility is desired. Airless spray is best for large scale operations not requiring very fine finish.

Both conventional and airless spray may be modified for increased performance or for specialized applications. One such modification includes adding heaters to fluid lines. The use of heated paint permits atomization at lower pressures, decreases or eliminates the need for thinning, cuts down an overspray rebound and provides a heavier film build with minimum waste of paint and solvents. The only drawback associated with hot spraying is that the pot life of catalyzed products sprayed by heated method is generally reduced.

Air Spray Application

A conventional air spray gun is a precision tool which uses compressed air to atomize sprayable materials. Air and paint enter the gun through separate passages and are mixed and ejected at the air nozzle to provide a controlled spray pattern. The amount of paint leaving the gun is controlled by the pressure on the fluid container, the viscosity of the paint, the size of the fluid orifice, and by the fluid needle adjustment.

Suggestions for effective air spray painting:

- **Use the lowest possible air and fluid pressure when operating a spray gun.**
- **Use the proper fan width for the job.**
- **Spray from the proper distance (6-10 inches).**
- **Hold the gun perpendicular to the work throughout the spray stroke.**
- **Move the spray gun parallel to the work surface throughout the spray stroke.**
- **Move the spray gun at a speed which assures that a full wet coat is applied to the surface.**
- **Overlap strokes at least 50%.**

Airless Spray Application

Airless spray is a method of application which does not directly use compressed air to atomize the coating sprayed. Hydraulic pressure is used to atomize the fluid by pumping it at high pressures (500-3500 p.s.i.) through a small precision orifice in a spray nozzle. As the fluid is released at these high pressures, it is separated into small droplets resulting in a finely atomized spray.

Since air is not used to form the spray pattern, the term "airless" is used to describe this method.
Airless spray painting is cleaner and faster than conventional spraying methods. One advantage of airless spraying is that the overspray fog or rebound associated with conventional spray is greatly reduced. This makes use of equipment possible in places and applications where material formerly had to be brushed.

Another significant advantage of airless spray is the ability to apply heavy coating thickness more quickly than by any other method. Most coating materials may be sprayed in their unthinned state which also helps contribute towards the formation of heavy films and greatly reduces thinner use.

Suggestions for effective airless spray painting:

The technique employed for airless spraying is similar to the technique practiced in air spraying.

- **The ideal spraying pressure for any given tip is achieved by gradually increasing the pressure until the spray pattern appears uniform across its fan width and the atomized coating particles are of acceptable size.**
- **If the coating is coarsely atomized, the pressure may be increased slightly, a smaller orifice tip used, or the coating thinned.**
- **Avoid using excessively high airless spray pressures, which may cause effervescence or other finish defects.**
- **Hold the gun perpendicular and move it parallel to the surface at all times in order to obtain a uniform coating of material.**
- **Arcing, heeling and toeing should be avoided at all times.**
- **The proper working distance with airless spray is approximately 10-15 inches.**
- **When using wide angle spray tips, the gun must be moved closer (approximately 10-12 inches) to the work.**
- **Excessive spray distances increase paint fog and paint consumption.**

Technique of spray application

Coating should be even and wet when spraying

3.5.4 Directions of Use

Air drying epoxy and polyurethane coatings are normally two component systems, consisting of a base and a hardener. The two components have to be mixed in the ratio recommended to ensure proper and complete curing of the coatings. Improper ratio leads to problems like soft/non-dried film, poor performance, etc.

The base and hardener are to be separately mixed first to obtain a homogenous mixture. The hardener is to be added to the base slowly, with continuous mixing/agitation and not the reverse. After complete addition, mixing/agitation is to be continued to achieve a homogenous mixture. Power agitation in preferred over hand mixing.

Any addition of thinner to achieve the application viscosity should be made only after the components are thoroughly mixed and not to the base/hardener or while mixing the two components.

After thorough mixing of the product, the maturation time as indicated in the product data sheet is to be allowed before applying the product. The mixture thickens as the time progresses, and at the end of the pot life period the mixture becomes highly viscous and unusable. It is best to consume mixed paint at least one hour before the end of the pot life.

Avoid using excess thinner than the recommended volumes, since this can lead to lower dft buildup, sagging, longer curing time, etc.

3.5.6 Directives for Ventilation Practice

Adequate ventilation is necessary for the safety as well the quality of the coating system. The amount and type of residual solvent in the coating can be detrimental to performance of coating, as it can affect adhesion, water resistance, mechanical and chemical properties. Very slow evaporation of trapped solvents can also develop internal stress due to shrinkage.

The ventilation must be maintained throughout the application process and also for a period after application is completed. Ventilation air should be directed to the base of the tank or compartment and should also be extracted by exhaust fans of correct balance capacity.

3.6 Guideline for Application of IZS

Surface Preparation

- **Remove oil, grease and other contamination with a suitable detergent, followed by high pressure water washing. Aromatic solvents can also be used to remove the contaminants.**
- **Ensure that all welds/weld seams are complete and continuous without any cracks and pinholes. Remove all weld spatters & round off all the sharp edges prior to further surface preparation. In case you find any traces of soap/alkali deposits on weld joints which are used for pressure testing, please remove the same by fresh water washing and scrubbing with stiff nylon brushes.**
- **After above operation, grit blast to Sa 2 ½ to Sa 3 of Swedish specification. For severe exposure conditions, grit blasting to Sa 3 is recommended for optimum results. The surface profile after blast cleaning shall be 50 -**
- **75 microns.**
- **Substrate temperature should be at least 3°C above dew point but not above 50°C.**
- **Relative humidity should be above 50%.**

Note:

- **Use steel grits, aluminium oxide grits or similar sharp edged abrasives, free of foreign matters and soluble salts.**
- **Steel grit with particle size of 0.2 - 1.0 mm or aluminium oxide of 0.4 - 1.8 mm should generally help to achieve the surface profile of 50 - 75 microns with 100 p.s.i. air pressure.**

Application

- **Inorganic zinc silicate coatings should be applied by spray application only. Brush application can be used only for touch-up areas.**

Air Spray:

Nozzle pressure- 43 - 57 p.s.i.
Nozzle orifice - 1.8 - 2.2 mm
Volume of thinner - 10 - 25 %

Airless Spray:

Nozzle pressure - 1700 - 2100 p.s.i.
Nozzle orifice - 0.48 - 0.64 mm
Volume of thinner - 10 - 25 %

Note:

- **Pressure pot must be fitted with an air driven agitator to maintain continuous mixing while application.**
- **The fluid hose should not be more than 15 meters long.**
- **Use specified thinner as given in the data sheet for thinning and cleaning.**
- **Apart from correct spray technique, the amount of thinner should be adjusted in such a way that the coating applied is wet and smooth just after application.**
- **The amount of thinner will depend upon site conditions such as temperature, humidity, wind flow, ventilation etc.**
- **Select small nozzles for spray application of complicated and non regular structures.**

Mixing of Paint

- **Stir/shake the hydrolysate part thoroughly before mixing. The powder portion (zinc dust) should be added to the hydrolysate component slowly with constant mechanical stirring. Continue stirring until the mixed paint is free from lumps.**
- **Filter the mixture through a wire screen of 30-60 mesh. Keep the mixture continuously stirred during application and ensure that it is used within 4 hours.**
- **Avoid part mixing of the paint.**

Drying and Curing

Inorganic zinc rich primers are sensitive to environmental conditions for drying and curing. This product requires minimum relative humidity of 50% and minimum steel temperature should be 10ºC. In case skin temperature of steel is more than 40ºC, spraying shall be done by extra thinning, to avoid dry spray application. The curing may be promoted at low humidity by spraying fresh water after 4-6 hours of application of primer and keeping the surface constantly wet until curing is complete. The complete curing can be checked by rubbing the coating with a cotton cloth soaked in thinner. If the coating remains unaffected, the curing is complete. The full hardness and curing will be obtained after weathering.

Film Thickness

The recommended dry film thickness of the primer shall be 50 - 75 microns.
Please note that high deposition of film thickness (125 microns +) can result in mud-cracking while lower dry film thickness can affect the performance of coating. In case one needs to augment the dft, apply one more coat of over-thinned primer within 24 hours.

Recoating

The most frequent problem associated when top coating is bubbling/pinholing especially with non-weathered zinc silicate coatings. To a great extent, this bubbling of finish paint can be eliminated by applying a mist coat of intermediate/topcoat as the first pass of the product, allow the bubbles to subside and then apply a full coat, as required.

Note:

In case recoating of zinc silicate with epoxy/chloro/polyurethane coatings is expected to be delayed, it is advisable to use a suitable tie coat to avoid formation of white rust.

The cleaning/secondary surface preparation of inorganic zinc rich primers before top coating depends on the condition of the primed surface.

Condition 1

Zinc silicate coating is intact with sporadic formation of white rust also called as zinc corrosion products.

- Remove oil, detergent, etc., by detergent wash
- Remove white rust by high pressure water jet washing (2000-5000 p.s.i.). If the surface is slightly contaminated, hosing down the surface with fresh water and scrubbing with stiff nylon brushes may be sufficient.
- Ensure that the primed surface is thoroughly dry before overcoating.

Condition 2

Damaged areas, burns, weld spatters etc.

- **Remove oil, grease, dirt, etc. by detergent wash**
- **Remove weld spatter**
- **Spot blasting to minimum Sa 2½ followed by removal of abrasive and dust by vacuum cleaning.**
- **Touch up with inorganic zinc silicate or suitable epoxy coating.**

Special Instructions

- **Excessive film build up more than recommended dft may lead to mud - cracking. In such a case the coating has to be reblasted.**
- **Application of second coat over the first coat should be avoided.**
- **The product should not be applied on surfaces, unless, blast cleaned to minimum Sa 2½ of Swedish specification.**
- **Painted structures should be kept at least 4 inches above ground.**

- **Use suitable sealer/tie coat over the primer in case of project painting, where the finish paint application is generally done after erecting the structures.**
- **Good ventilation is essential in confined areas.**
- **Painters should wear adequate personal protective equipments e.g. air fed mask, safety glasses, etc.**
- **Keep away the material from flame and sparks. Protect zinc dust against moisture.**

3.7 Conclusion

"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 in- complete"

Chapter 4 Coating Application Types and Technologies

There are about a dozen different ways to apply paint. Each one in uniquely suited to a particular job. This section gives an overview of several types of industrial plant application methods and their strengths and weaknesses.

Besides the "conventional" method of applying coatings, many choices exist for someone who is involved in painting or coating operations. The right choice for you depends on your particular business operations—the type of pieces you coat; the finished appearance requested by customers; money available for equipment, training, and maintenance costs; and even how much room you have in your business.

The following are summaries of some available technologies.

4.1 Low-Volume High –Pressure (LVHP)

Low-volume high-pressure spray (LVHP) is considered the conventional method of applying coatings. It depends on air-atomizing the paint at pressures of 40–70 pounds per square inch (psi). Air is supplied from an air compressor or turbine. While these spray systems create high quality finishes at high production rates, they do have several disadvantages, including extensive overspray, increased booth cleanup costs, and increased filter use and related costs. Additionally, if a higher coating thickness is necessary, more operator passes may be necessary to get the desired mil thickness, and hence application time is increased.

4.2 High-Volume Low –Pressure (HVLP)

The principle of high-volume low-pressure (HVLP) has been applied to "conventional" spray guns to apply paint with a high volume of dispersing air at low pressures. HVLP guns have nozzles with larger diameter openings for atomizing air, can be bleeder or non-bleeder types, and require air volumes of 10–30 cubic feet per minute. Air and fluid delivery to the spray gun affect the efficiency, ease of use, cost, and versatility of HVLP sprayers.

In a siphon-fed HVLP system, air pressure to the sprayer is used to pull paint from the cup located below the gun, producing a fully atomized pattern for even surface coverage. Gravity-fed HVLP systems are well adapted for higher viscosity paints, such as clears, water-based paints, high-solids paints, and epoxy primers, given the paint cup location. The cup, located at the top of the gun, allows paint to completely drain, minimizing paint waste.

HVLP guns allow operators to finish intricate parts with comparable quality to conventional sprayers. This makes them a good choice for small shops that finish smaller, more intricate parts which demand a higher level of gun control. Other advantages of the HVLP system include the following:

- ✓ **Transfer efficiencies, from 50 to 90 percent reported, depending on the air-delivery system used**
- ✓ **Reduced amount of overspray, and hence material use**
- ✓ **Reduced VOC and HAP emissions**
- ✓ **Reduced paint booth filter use and cleanup costs**
- ✓ **Reduced worker exposure due to high-pressure "blowback" from the spray**
- ✓ **Good coverage of intricate parts**
- ✓ **Finish quality comparable to conventional air sprayers**
- ✓ **Comparable transfer efficiencies to air-assisted airless sprayers at low-fluid delivery rates, with low to medium viscosity fluids**
- ✓ **More efficient air atomization**
- ✓ **Air-spray coating adaptable to any size coating operation and application rate**
- ✓ **Equipment fittings allow for fast color changes and application of very different fluid viscosities**

HVLP systems, however, do have some disadvantages, including difficulty in obtaining higher fluid delivery rates with high viscosity materials, and a lack of sufficient atomization required for some fine finishes.

4.3 Air spray

The air spray gun uses air at 30 to 85 pounds per square inch (psi) to atomize the paint into a fine spray. This produces a smoother finish, and can be used on many surfaces. Air spraying is versatile; the operator can vary the air pressure, air volume, paint pressure, and spray pattern. It is much faster than painting by hand unless a lot of masking is required for the job. But air spraying does produce a lot of overspray (the paint that misses the intended target), and preparation and clean-up take more time.

A High Volume Low Pressure (HVLP) spray gun uses a higher volume of air at only 10 psi. This reduces the overspray and increases the transfer efficiency. It is portable and easy to clean, and has a lower risk of blowback to the worker. However, the atomization may not be good enough for fine finishes, and production rates when using HVLP may not be as high as with conventional spraying.

4.4 Airless Spray

This method uses paint under high pressure, 500 to 6,500 psi. Airless spraying has several distinct advantages over air spray–it is twice as fast, produces a higher film build, is more portable, cuts overspray by more than half, and is thus cleaner and more economical. But airless spray is limited to painting large areas, requires a different nozzle to change spray patterns, the nozzle tends to clog, and the nozzle can be dangerous to use or to clean because of the high pressures involved.

4.5 Electrostatic Spraying

The differences between this and air spraying are that the electrostatic gun has an electrode at the nozzle and the object to be painted is grounded. The electrode runs 60,000 volts through the paint at 225 microamperes. The charged paint is attracted to the grounded object. This requires less pressure, produces little overspray, and uses relatively little paint. Electrostatic guns are good for painting oddly shaped objects. They also produce a uniform coat because the paint itself acts as an insulator; once the object is covered, it can take no more paint.

The disadvantages are: only one coat is possible, only conductive materials can be painted; it's more expensive, slower, has higher maintenance costs, is limited to chargeable paints, and the surface of the object must be extremely clean. Because the gun uses electricity, this method presents a possible shock hazard.

4.6 Powder Coating

This is a variation of electrostatic spraying. The difference is that what is sprayed is a paint powder. The object is then bake, and the powder melts into a smooth, durable coat. Overspray can be reused, and no other pollutants are created or released because the powder has no solvents in it. The equipment for powder coating is expensive, so it may be economical for only larger businesses. A variation of this is plasma powder coating. The powder is fed into an extremely hot gas stream and is then sprayed at the object. Plasma powder coating is for large objects that can't fit into a conventional curing oven. Overspray cannot be reused because it hardens.

Another variation is flame sprayed powder coating, where the powder is melted with a high temperature flame. Again, it is for large objects and overspray cannot be reused.

4.7 Rotary Atomizing

Another variation of electrostatic painting, rotary atomizers use centrifugal force, not air or hydraulic pressure, to drive the paint out of the nozzle. The atomization of this method is excellent, as is the transfer efficiency. This method can also be used with paints of different viscosity. Cleanliness is especially important to this method. Rotary atomizers can present a fire and safety hazard.

4.8 Dip Coating

With this process, parts are dipped into a vat of paint. This allows for a high production rate and transfer efficiency, and it requires relatively little labor. The effectiveness of dip coating depends greatly on the viscosity of the paint, which thickens with exposure to air unless carefully managed. Dip coating is not suitable for objects with hollows or cavities, and generally the finish is of lower quality.

4.9 Flow Coating

With this method, parts are carried on a conveyor. Anywhere from 10 to 80 streams of paint coat the parts. This system has the advantages of dip coating, along with low installation costs and low maintenance requirements. The quality of the finish is also about as good as with dip coatings.

4.10 Curtain Coating

Instead of many streams of paint, curtain coating uses a waterfall flow of paint to coat parts on a conveyor belt. Curtain coating has a high transfer efficiency and covers parts uniformly, but is suitable only for flat work. The quality of the finish is highly dependent on the viscosity of the paint.

4.11 Roll Coating

Paint is applied to auxiliary rollers, which then transfer the paint to the application rollers, which run across the part. This method has a high transfer efficiency and high production rates, but is limited to flat work.

4.12 Electro coating (or Electrode position)

Parts to be painted are dipped into the paint. Then a current is applied, which electrically deposits the paint on the object. Parts are made primarily of steel. The transfer efficiency of electro coating is over 90%. High production rates are possible, and production can be automated. However, this method is costly and requires a lot of energy. Also, employees need high level training to use this system.

4.13 Auto deposition

This is a dip process where organic paints are precipitated onto iron, steel, zinc and zinc-alloy plated objects. It is effective for its anti-corrosion properties and coverage of objects. Auto deposition also uses water-borne paints and uses no electricity. But auto deposition produces a dull or low gloss finish and has few available colors.

[For further information visit www.hazard.uiue.edu/wmr]

Chapter 5 Comparison of Coatings

5.1 Introduction

Traditionally, paint has been considered a liquid made up of several components that when applied and cured impart a thin plastic film. Paints have traditionally been organic solvent-based, with the solvents aiding in the application process. While being versatile, it has many environmental issues associated with its use, including air emissions and hazardous waste disposal. High-solids paints have a higher percentage of paint solids and contain less solvent, and while air emissions may be less, they are still present. Water based paints, which utilize water as the solvent, also have reduced VOC emissions, as well as a reduced fire hazard. "Solid paints," such as powder coatings and paints containing no solvents (and hence have reduced HAP and VOC emissions), are widely available. These materials have given rise to the term "coatings" instead of paints. With catalyzed or two-component coating systems, reactive resins and catalysts are mixed just before entering the application equipment. This type of coating system can also reduce solvent use.

The following provides a comparison of four different coating technologies

5.1.1 High-solids Coatings (where the paint was modified to produce a coating with higher solids concentration and a lower VOC concentration)

Pollution prevention benefits:

- **Reduces solvent in coatings**
- **Less overspray compared to conventional coatings**
- **Higher transfer efficiencies**

Operational benefits:

- **Can apply thick or thin coat**
- **Easy color blending or changing**
- **Compatible with conventional and electrostatic application equipment**

Energy savings:

- **Reduced air flow in work spaces and curing ovens (low VOC)**
- **Reduced energy needed for heating makeup air**

Applications:

- Zinc-coated steel doors
- Miscellaneous metal parts
- Same as conventional coatings

Limitations:

- Solvent use not completely eliminated
- Shorter pot life than conventional coatings

5.1.2 Water- Based Coatings (which mainly use water to disperse the paint resin, although some solvent is still present)

Pollution prevention benefits:

- Eliminates or reduces solvent in coatings
- Reduced VOC emissions and fire hazards
- Reduced hazardous waste disposal
- Water used for cleanup

Operational benefits:

- Can apply thick or thin coat
- Easy color blending or changing
- Compatible with conventional and electrostatic application equipment

Energy savings:

- Reduced air flow in work spaces (little or no VOC)
- Reduced energy needed for heating makeup air

Applications:

- wide range
- Architectural trade finishers
- Wood furniture
- Damp concrete

Limitations:

- Coating flow properties and drying rates can change with humidity, affecting coating application
- Sensitive to humidity, workplace humidity control required

- May have poor flow characteristics due to high surface tension of water
- Special equipment needed for electrostatic application
- Water in paint can cause corrosion of storage tanks and transfer piping, and "flash rusting" of metal substrates

5.1.3 Powder Coatings (which have become a viable alternative for decorative and functional coatings, although still predominately a metal-finishing process)

Pollution prevention benefits:

- Eliminates solvent in coatings
- Little or no VOC emissions
- Easier to recycle and reuse over-spray
- Reduces solvents for cleaning
- Reduces need for solid paint waste disposal

Operational benefits:

- Can apply thick coat in one application
- No mixing or stirring
- Efficient material use, possible to achieve nearly 100% transfer efficiency if a reclaim system is used

Energy savings:

- Little air flow needed for worker protection (no VOC)
- Little energy needed for heating makeup air

Applications:

- Steel
- Aluminum
- Zinc and brass castings

Limitations:

- Requires handling of heated parts
- Part must be electrically conductive, complex shapes difficult to coat
- Difficult to apply thinner coatings
- Need special equipment or extra effort to make color changes
- Difficult to incorporate metal flake pigments

5.1.4 UV-cured coatings (coatings requiring UV radiation to initiate crosslinking of the resin).

Pollution prevention benefits:

- Eliminates solvent in coating
- Allows for increased production rates
- 100% reactive liquid

Operational benefits:

- Can apply thin coats
- Easy color blending or changing
- Efficient material use, nearly 100% transfer efficiency

Energy savings:

- Little air flow in work spaces (no VOC)
- Cure with UV instead of an oven
- Little energy needed for heating makeup air

Applications:

- Some metal applications
- Filler for chipboard
- Wood
- "Wet look" finishes

Limitations:

- Styrene volatility
- Typically best applied to flat materials
- Limited to thin coatings
- High capital cost of equipment
- Yellow color

Chapter 6 Paint Trouble Shooting – Paint Problems and Solutions

6.1 Introduction

Paint Problems are easy to spot, but in many cases quite difficult to analyze. This section is prepared to assist applicators. The section contains information and advice from experienced users and applicators, technicians, and product developers.

6.2 Problem: Blistering

______________________________ Basecoat/Topcoat
______________________________ Sealer
______________________________ Primer
______________________________ Substrate

Fig 1.1 Blistering

<u>Description:</u>

- **Hollow bubbles in the paint film.**

<u>Identification:</u>

- **Bubbles in or under the finish (0.5 to 1.5 mm)**
- **May follow the shape of a repair spot**
- **Most common on horizontal surfaces**
- **May contain a vapor or a liquid**

<u>Probable Cause</u>

- **Excessive moisture in air supply while priming/top coating**
- **Primer not allowed to dry thoroughly**
- **Improperly cured 2-part polyester body**
- **Topcoat immersed in water for extended periods of time**

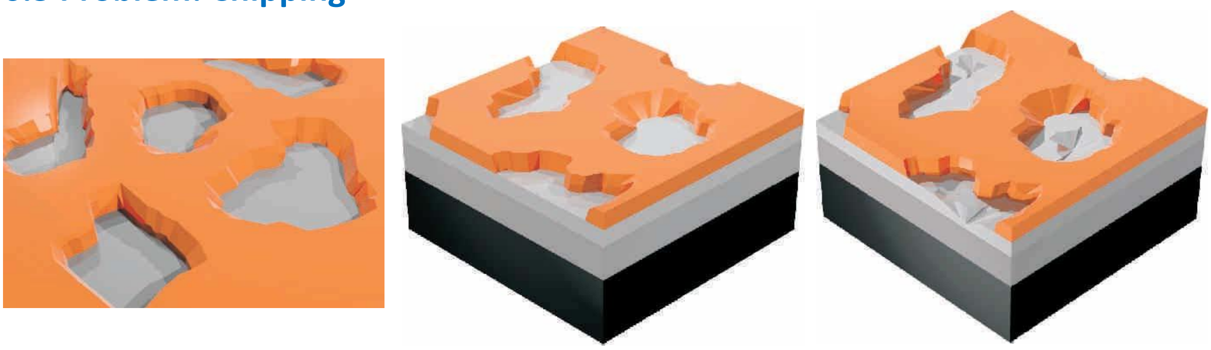
Remedy

- Check for moisture damage
- Use recommended epoxy fillers
- Apply primer/sealer
- Repaint

Prevention

- Allow sufficient drying times
- Use EP-2C Hi-Build Epoxy Primer (waterproof at 12.0 mil) in high moisture conditions
- Cover painted articles for long term storage with a non-airtight cover

6.3 Problem: Chipping



Basecoat/Topcoat
Sealer
Primer
Substrate

Fig 1.2 Chipping

Description:

- Small pieces of paint film breaking away.

Identification

- Small pieces of paint film missing
- Pinhole size to thumbnail size each
- May be exposing an underlying layer
- Usually seen on leading edges

Probable Cause

- Surface impact
- Using HS-421 Primer without sealing before applying topcoat
- Exposure to harsh conditions- Frequent use on gravel roads

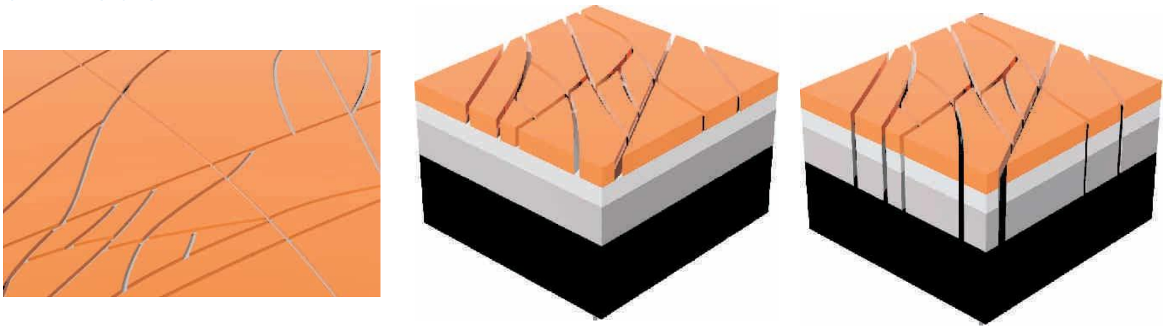
Remedy

- Small chips can be filled with 2-part
- Large chips or large areas with chipping should be blended - follow proper Blending Procedure
- Select the most suitable coatings for environmental conditions
- Repeat all steps in application procedure

Prevention

- Avoid use of HS-421 Primer in high impact areas
- Use EP-321 Epoxy Primer or EP-521
- Epoxy Primer for industrial service (sandblasted steel, etc.)
- Use EX-2C TF-2K Topcoat for severe conditions

6.4 Problem:



Cracking

Basecoat/Topcoat
Sealer
Primer
Substrate

Fig 1.3 Cracking

Description:

- Splitting throughout the paint film thickness.

Identification

- Topcoat splitting
- Series of straight lines
- Primer or substrate may be visible

Probable Cause

- Substrate not at room temperature
- Component “A” and Component “B” not uniformly mixed
- Coating applied over a previously cracked finish or unstable substrate Excessive total film thickness

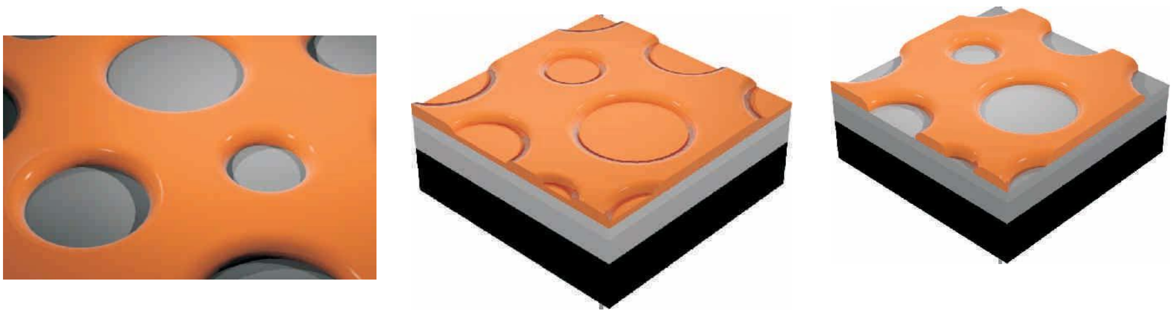
Remedy

- Remove finish from affected area
- Apply primer/sealer
- Repaint

Prevention

- Remove poor quality/unstable finishes Check current film thickness before starting. Excessive paint should be removed before refinishing.
- Mix Component “A” and Component “B” thoroughly
- Follow recommended film thickness
- Follow recommended flash-off and drying time between coats

6.5 Problem: Creating / Fish Eyes



Basecoat/Topcoat
Sealer
Primer
Substrate

Fig 1.4 Cratering / Fish eyes

Description:

- **Usually occurs while spraying or immediately after.**
- **Paint film marked with round surface depressions or bowl-like craters.**

Identification

- **Usually sporadic, confined to specific contaminated areas**
- **Previous coat is visible**
- **The centre may contain a particle**

Probable Cause

- **Surface contamination:**
  - **Silicone or wax based protective coatings or polishes**
  - **Hand prints**
  - **Grease, oil, diesel fuel**
  - **Wash solvents containing naphtha**

- **Contaminated booth air intake**
- **Insufficiently dried surface contaminated in shop/drying area**
- **Continual use of proper Crater Eliminator**

Remedy

- **If noticed while painting:**
  - **Stop painting**
  - **Allow flash-off**
  - **Re-mix coating, adding more EX-2C Thinner:**
    - **1 part Component "A"**
    - **1 part Component "B"**
    - **2 parts EX-2C Thinner**
- **Continue to paint subsequent coats at the normal mix ratio**
- **Major problem:**
  - **Allow to dry thoroughly**
  - **Determine and remove the contaminant**
  - **Sand smooth**
  - **Clean substrate thoroughly with soap and water**
  - **Repaint**

Prevention

- **Proper surface preparation: use water-based cleaning solutions**
- **Ensure compressed air is not contaminated with oil and water Protect against diesel exhaust fumes and other air-borne contaminants**
- **Maintain a clean shop**
- **Use recommended amounts of proper Crater Eliminator**

- Mist on the 1st coat of topcoat
- Allow booth exhaust fan to run as long as possible
- Provide a clean working area
- Wear clean protective equipment including latex or nitrile gloves

6.6 Problem: Crawling

Basecoat/Topcoat
Sealer
Primer
Substrate

Fig 1.5 Crawling

Description:

- Usually occurs with clear coats.
- Wet paint film receding, leaving some areas uncoated.

Identification

- Lack of adhesion while spraying
- Coating varies from 'not hiding' to 'accumulated'
- Previous coat is visible
- Commonly occurs along edges or around rivets

Probable Cause

- A film of surface contamination
- Re-coating a painted or clear coated surface already high in silicone content

Remedy

- Sand smooth
- Repaint

Prevention

- Proper surface preparation: use water- based cleaning solutions
- Frequently replace tack cloths and rags used to solvent wipe
- Pay special attention wiping edges and problem areas
- Reduce product for the first coat of topcoat
- Mist on the first coat of topcoat

6.7 Problem: Delamination

Basecoat/Topcoat
Sealer
Primer
Substrate

Fig 1.6 Delamination

Description:

- Usually occurs around edges, trim, or hardware.
- Paint film not adhering to the substrate, or, layers of paint film separating.

Identification

- Large pieces of coating peeling off
- Film peels off easily

Probable Cause

- Contaminated surface
- Metal conditioner and/or appropriate primer was not used
- Insufficient flash-off time between coats
- Poor quality sanding

- Incorrect film build-too heavy
- Incorrect Spray Technique:
  - Coating applied too dry or too heavy
- Insufficient flash off time between coats (and or between primer and topcoat)

Remedy

- Featheredge the problem areas Use sealer as recommended Repaint
- Reduce total film thickness

Prevention

- Follow recommended topcoat window Follow recommended film builds, topcoat will delaminate if applied over an insufficient primer coat
- Follow recommended viscosity Follow recommended flash-off times
- Carefully sand edges and areas around hardware
- Use recommended metal conditioner and conversion coating
- Clean thoroughly with recommended water-based cleaners
- Mix Component “A” and Component “B” thoroughly

6.8 Problem: Dissolution

______________________________ Basecoat/Topcoat
______________________________ Sealer
______________________________ Primer
______________________________ Substrate

Fig 1.7 Dissolution

Description:

- Unique to metallic paints.
- Basecoat metallic flakes surfacing in the clearcoat

Identification

- Altered colour
- Exaggerated metallic appearance.

Probable Cause

- Insufficient flash-off time between basecoat and clearcoat

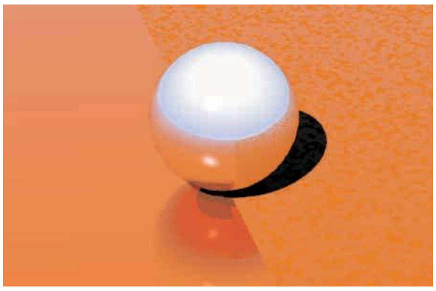
Remedy

- Allow the paint to dry
- Sand smooth
- Repaint base and clear

Prevention

- Correct gun set up
  - use recommended air pressure
- Use recommended amounts of paint by vendor
- Super Catalyst II in the basecoat
- Follow recommended flash-off times
- Follow recommended viscosity

6.9 Problem: Dry Spray



______________________________	Basecoat/Topcoat
______________________________	Sealer
______________________________	Primer
______________________________	Substrate

Fig 1.8 Dry Spray

Description:

- Areas of paint film lacking gloss.

Identification

- Dull surface with a grainy texture

Probable Cause

- Improper gun setting - insufficient fluid feed
- Gun air pressure regulated too high
- Viscosity too high

- Wrong thinner used - too fast
- Incorrect spray technique:
  - Holding spray gun too far from surface or passing too quickly resulting in an insufficiently wet film

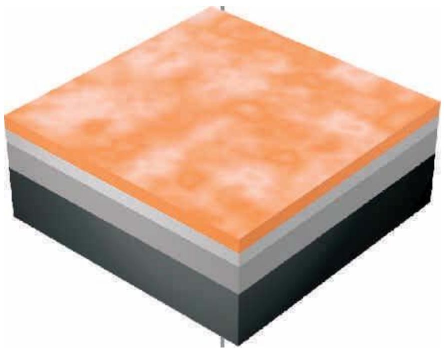
Remedy

- Allow the paint to dry
- Sand smooth
- Repaint

Prevention

- Only use repute manufacturers' thinners/reducers, at recommended amounts (up to 50% by volume, based on equipment used)
- Use a slower thinner and retarder
- Adjust gun set-up, fluid feed
  - Follow recommended air Pressure
  - Use larger size fluid tip
- Alter spray technique, spray pattern

6.10 Problem: Mottling



______________________________ Basecoat/Topcoat
______________________________ Sealer
______________________________ Primer
______________________________ Substrate

Fig 1.9 Mottling

Description:

- Unique to metallic paints.
- Concentrations of metallic flakes in the paint film.

Identification

- A cloudy or blotchy appearance.

Probable Cause

- Improper equipment: type of gun, size of nozzle
- Improper gun settings
- Incorrect spray technique:
  - Holding spray gun too close to surface
  - Uneven spray pattern
  - Application too heavy
- Wrong thinner/reducer for shop temperature
- Component "A" and Component "B" not thoroughly mixed

Remedy

- Sand smooth
- Repaint

Prevention

- Correct gun set-up:
  - Decrease nozzle tip size
  - Increase air pressure to provide more atomization
  - Decrease fluid pressure in pressure pot
- Proper selection of solvent for shop conditions
  - In cold conditions use fast solvent
  - In hot conditions use slow solvent
- Use a Hi-Hide Basecoat followed by Clear 221
- Use correct technique for applying

6.11 Problem: No Hold Out

______________ Basecoat/Topcoat
______________ Sealer
______________ Primer
______________ Substrate

Fig 1.10 No Hold Out

Description:

- The primer or sealer notwithstanding the solvent from the topcoat.

Identification

- Coating has lost gloss
- Sand scratches or other substrate flaws show through the paint film

Probable Cause

- Unstable substrate
- Wrong sandpaper grit - too coarse
- Primer oversanded
- Primer uncured
- No sealer was used on aged or spot primed finishes

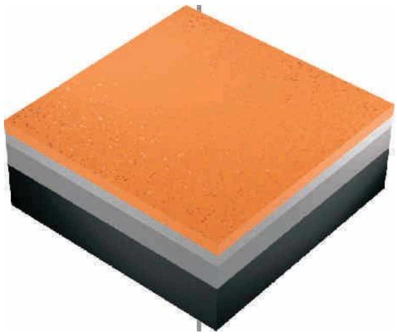
Remedy

- Sand smooth
- Use sealer if necessary
- Repaint

Prevention

- Use urethane, polyester, or epoxy fillers and repute manufacturers' primers
- Use sealer if uncertain about substrate stability
- Follow repute manufacturers' recommendations for sanding
- Use repute manufacturers' Super Catalyst II as recommended
- Allow sufficient flash-off times between primer and topcoats
- Allow a longer flash-off time between coats

6.12 Problem: Orange Peel



Basecoat/Topcoat
Sealer
Primer
Substrate

Fig 1.11 Orange Peel

Description:

- Dry paint film has a dimpled surface.

Identification

- Paint finish looks like the peel of an orange

Probable Cause

- Viscosity too high
- Gun air pressure too low (causing lack of atomization)
- Primer or sealer applied not smooth
- Wrong thinner/reducer
- Incorrect spray technique:
  - Holding gun too far from surface
  - Wide fan patterns
- Wrong amount of thinner or reducer used - not enough
- Poor quality sanding

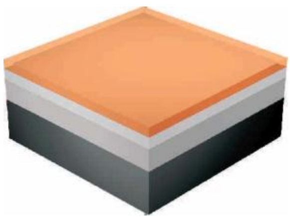
Remedy

- Sand smooth
- Repaint topcoat

Prevention

- Proper surface preparation: carefully sand smooth
- Check viscosity of products
- Adjust gun set up:
  - Use smaller size fluid tip
  - Use air cap that increases paint atomization
- Use recommended solvent

6.13 Problem: Poor Hiding



_______________________________ Basecoat/Topcoat
_______________________________ Sealer
_______________________________ Primer
_______________________________ Substrate

Fig 1.12 Poor Hiding

Description:

- Paint film not covering adequately.

Identification

- Insufficient total film thickness
- Finish has a transparent appearance
- Dull finish, not glossy

Probable Cause

- Insufficient film build
- Not using basecoat when required for transparent colours
- Wrong amount of thinner/reducer - too much
- Insufficient lighting in the spray booth

Remedy

- Sand smooth
- Repaint

Prevention

- Use recommended Hi-Hide formulation
- Use the recommended base colour
- Use a tinted primer when recommended
- Follow repute manufacturers' recommendations for reduction and number of coats
- Provide good lighting for spraying

6.14 Problem: Runs or Sags

_______________ Basecoat/Topcoat
_______________ Sealer
_______________ Primer
_______________ Substrate

Fig 1.13 Runs or Sags

Description:

- Usually occurs on vertical surfaces.

- **A heavy paint film collects and moves downward, setting in ripples.**

Identification

- **A rippled, distorted paint film**

Probable Cause

- **Improper equipment set-up**
- **Gun air pressure too low (causing lack of atomization)**
- **Shop or substrate temperature too low**
- **Temperature of paint product too low**
- **Insufficient lighting in the spray booth**
- **Incorrect solvent for conditions**
- **Wrong amount of thinner/reducer used**
  -too much
- **Incorrect spray technique**
  -Holding gun too close to surface
  -Application too heavy

Remedy

- **Sand smooth**
- **Repaint**

Prevention

- **Maintain a suitable, consistent shop temperature and airflow**
- **Allow surface to warm up to at least room temperature before applying paint**
- **Store paint products at room temperature**
- **Provide good lighting for spraying Use proper gun settings and air pressure**
  - Use smaller size fluid tip
  - Increase gun air pressure/increase atomization
  - Decrease pot pressure
- **Use correct solvent for conditions**
  -fast solvents for cold conditions
- **Allow sufficient flash-off and drying time between coats**

6.15 Problem: Sandscratch Swelling

Basecoat/Topcoat
Sealer
Primer
Substrate

Fig 1.14 Sandscratch Swelling

Description:

- Usually occurs when painting over repair work.
- Sanding scratches in the previous layer swell through the paint film.

Identification

- Swollen scratch lines that follow the direction of sanding
- Unusual light reflections

Probable Cause

- Improper surface preparation
- Primer not allowed to dry thoroughly
- Insufficient flash-off time between coats
- Original finish incompatible with manufacturers' products
- Excessive primer film build

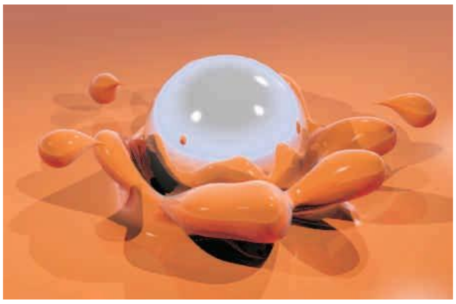
Remedy

- Sand smooth
- Apply sealer
- Repaint

Prevention

- Proper surface preparation: check recommended sandpaper grits
- Finish any polyester type filler with a finer grit sandpaper
- Completely seal porous substrates (sealer eliminates sandscratch swelling)
- Follow recommended primer film thickness
- Allow sufficient flash-off time between coats

6.16 Problem: Slow Drying



_____________________________ Basecoat/Topcoat
_____________________________ Sealer
_____________________________ Primer
_____________________________ Substrate

Fig 1.15 Slow Drying

Description:

- Coating does not cure within the usual time frame.

Probable Cause

- Wrong amount of “B” component used
  - too little or too much
- Insufficient flash-off time between coats
- Poor drying conditions: drying area too cool
- Solvent too slow
- Incorrect spray technique:
  - Application too heavy

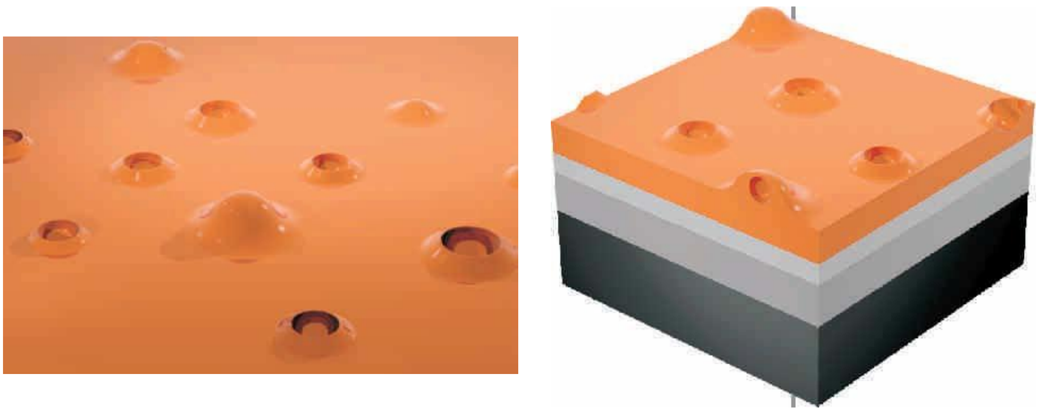
Remedy

- Drying area should be well ventilated and warm
- Drying may be accelerated by increasing booth temperature after spraying

Prevention

- Use correct amount of Component “B” Use recommended thinner
- Use Suitable Catalyst as recommended by repute manufacturer
- Use a faster solvent system Follow film thickness recommendations
- Allow sufficient flash-off time Increase booth temperature after an adequate flash-off period

6.17 Solvent Popping



Basecoat/Topcoat
Sealer
Primer
Substrate

Fig 1.16 Solvent Popping

Description:

- Small blisters or bumps on the paint film surface.

Identification

- Smooth blisters or bumps, some may have popped and appear as cratering
- Usually occurring on horizontal surfaces

Probable Cause

- Improperly cured polyester fillers
- Incorrect spray technique:
  - Application of the primer too heavy
  - Coating applied too dry
- Insufficient flash-off or drying time between coats
- Wrong thinner/reducer used
- Too much flash-off time before force drying
- Baking temperature too high

➢ Excessive use of Super Catalyst II

Remedy

➢ Minor problem:
  - Sand smooth
  - Apply sealer
  - Repaint
➢ Major problem:
  - Remove finish
  - Repaint

Prevention

➢ Ensure polyester type fillers are fully cured before priming
➢ Completely seal porous substrates
➢ Use correct solvent for conditions- slow solvent for hot conditions
➢ Follow recommended film build thickness
➢ Allow sufficient flash-off time between coats
➢ Flash-off time of 5-10 minutes before forced drying

6.18 Water Spotting

______________________________ Basecoat/Topcoat
______________________________ Sealer
______________________________ Primer
______________________________ Substrate

Fig 1.17 Water Spotting

Description:

➢ Patches of whitish discolouration on the paint film.

Identification

➢ Patchy areas may be:
  - Slightly indented
  - Dull, not glossy

- Cloudy, whitish

Probable Cause

- Coating was exposed to moisture in the first 24 hours after painting
- Coating was washed before the finish was cured

Remedy

- Minor problem: polish
- Major problem:
  - Sand smooth
  - Repaint

Prevention

- Follow recommended cure times before washing or exposing to rain
- Increase spray booth temperature
- Use suitable Catalyst in topcoats as recommended

6.19 Wrinkling

Description

- The film surface skins over and then swells, forming irregular ridges and creases.

Identification

- Paint film forms creases, folds, and slight ridges
- Film surface appears thick and leathery

Probable Cause

- Solvent sensitive enamel under topcoat or primer
- Primer or sealer not cured thoroughly
- Incorrect spray technique:
  - Application of topcoat too heavy
- Wrong amount of "B" component used - too little

Remedy

- Remove finish
- Apply sealer
- Repaint

Prevention

- **Check solvent sensitivity - perform a solvent rub test on existing finishes**
- **Use sealers where appropriate**
- **Allow sufficient flash-off times between coats**
- **Use correct amount of Component “B”**

Chapter 7 Pollution Prevention for the Coating Industry

7.1 Introduction

Pollution prevention, or P2, means preventing wastes rather than using expensive treatment and control technologies on end-of-pipe wastes. P2 can decrease environmental liabilities, reduce waste disposal costs, and improve working conditions. It may be as simple as preventing spills and leaks through better housekeeping and maintenance, or as complex as switching solvent-cleaning systems.

7.2 Development of Pollution Prevention Concepts

In 1990, beginning with the Pollution Prevention Act, EPA shifted focus from "end-of-pipe" pollution treatment and cleanup to policies, technologies, and processes that prevent and minimize the generation of pollution. The underlying theory behind P2 is that it is economically more sensible to prevent wastes than implement expensive treatment and control technologies to ensure waste does not threaten human health and the environment.

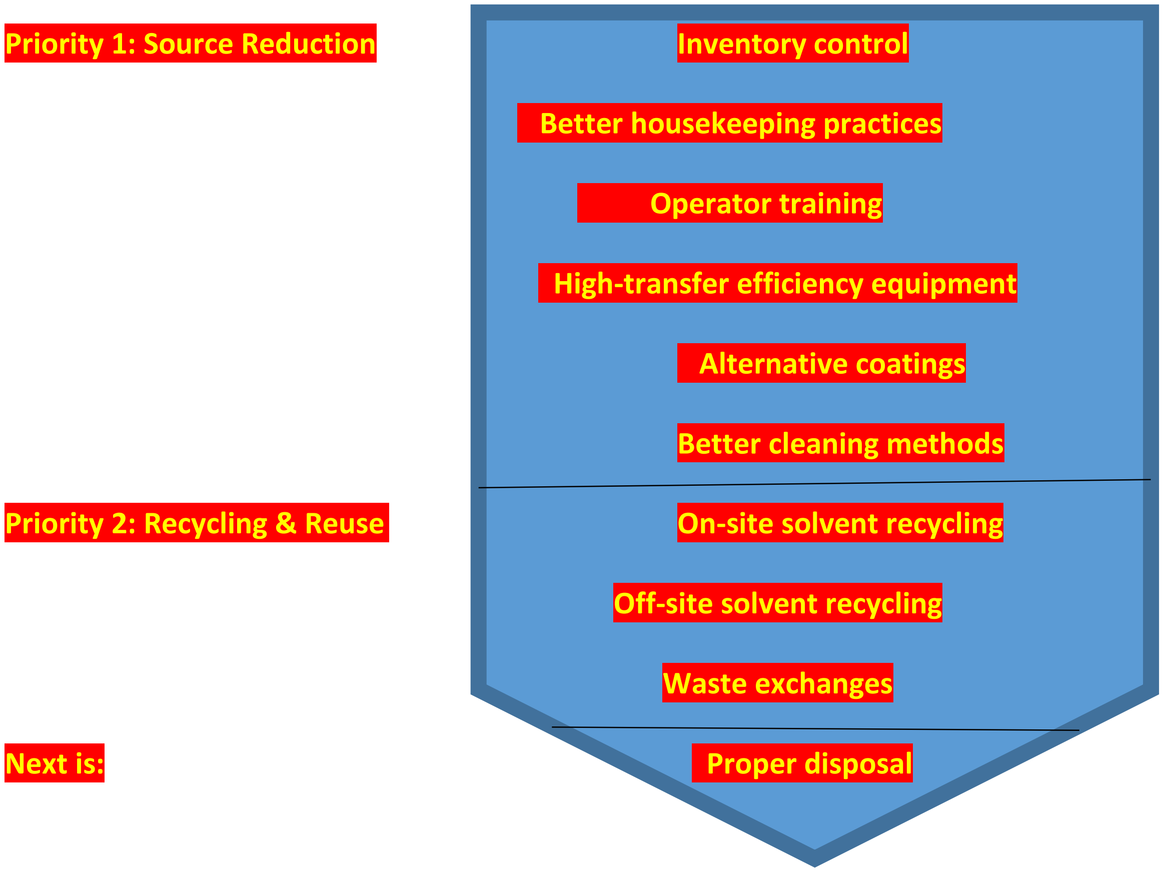
7.3 P2 and the Coating Industry

Paint application wastes include leftover paints, dirty thinner from cleaning spray guns and paint cups, air emissions of volatile organic compounds (VOCs) and hazardous air pollutants (HAPs), dirty spray booth filters, dirty rags, and disposal of outdated supplies. Ways to reduce these wastes include rigid inventory control, better housekeeping practices, mixing paint according to need, better operator training, proper cleaning methods, using alternative coatings, using Styrofoam filters, recycling solvents on and off site, and using waste exchanges.

Better operating practices, or "good housekeeping" applies to all waste streams and requires minimal capital investment, yet can be very effective in reducing the amount of wastes generated. Good housekeeping includes management initiatives to increase employee awareness of the need for and benefits of pollution prevention, and preventive maintenance to reduce the number of leaks and spills.

Waste assessments help identify the amounts and types of wastes generated at your facility. Knowing this makes it easier to know how waste can be reduced and where to concentrate your efforts. Any waste management program is an organized and continuous effort to systematically reduce waste generation, and should reflect the goals and policies of management. An effective program also includes the involvement and enthusiasm of employees, especially those who have an understanding of the processes being examined.

7.4 Hierarchy of Pollution Prevention Strategies for Coating Operations



7.4.1 Priority 1: Source Reduction

Source reduction techniques are designed to reduce the amount of waste initially generated. Simple housekeeping changes and conducting periodic inspections of all equipment can be less expensive than fixing malfunctions when they appear, or cleaning up a preventable spill.

7.4.1.1 Inventory Control

Inventory control is an effective and efficient way of reducing indiscriminate use of raw materials. By reducing the amount of paint that becomes unusable, you not only save costs associated with waste disposal, but you also save costs associated with initial product purchase. Mark receiving dates on your incoming paint products, and use a "first in, first out" procedure to use older paint materials first.

Look at standardizing the paint types and colors you offer your customers. This can help minimize the number of different paint products you keep in inventory, again lessening the chance for paint product to go bad. Standardizing your paint types and colors also provides you with another benefit—it minimizes the chance that a client's particular paint selection will provide you with a surprise and cause what may have previously been a non-hazardous waste to become a new hazardous waste for you to handle. If justified by volume demand, purchase your chief coating colors in 15-, 30-, or 55-gallon reusable drums rather than 5-gallon pails. Just be sure that product won't sit around too long.

If you have paint material that for one reason or another will not meet your clients' specifications or expectations as a finished coat, use it as an undercoat or primer; or see if you can find a business that can use the paint and sell it, even at reduced cost.

Monitor the amount of paint used by different workers to get the same jobs done. Shop owners may monitor employee operations and make verbal or written comments on product usage. Limit employee access to material storage areas, or develop some kind of accounting system to track material use.

7.4.1.2 Better Housekeeping Practices

Basic housekeeping techniques can be very effective in reducing pollution. Many methods are available to control and minimize material losses, which can be implemented easily and at little or no cost to the operator. Specific approaches to bulk material drum location, material transfer methods, evaporation, and drum transport can effectively limit material loss.

- ✓ **Keep paint and solvent containers tightly closed to reduce evaporation, emissions, and material dry-out.**
- ✓ **Reduce leaks and spills by placing drums at points of highest use.**
- ✓ **Use spigots or pumps when transferring materials from storage containers to smaller containers.**
- ✓ **Control evaporation by using tight-fitting lids and spigots.**
- ✓ **Use drip pans.**
- ✓ **Use secondary containment in bulk storage areas.**
- ✓ **Move drums carefully to prevent damage or punctures, which could lead to leaks or ruptures during future use.**

7.4.1.3 Material Preparation

Look for ways to reduce the amount of solvent used in product pre-cleaning. Examine substituting chemical cleaning for physical or mechanical cleaning when preparing the product surface for painting application. Sand or particle blasting are some examples, although they have their own environmental issues. Plastic media has been substituted for sand in some blasting operations for both environmental and worker health issues. The plastic media can be reused once separated from the stripped-paint waste, reducing both purchasing and waste disposal costs. Dry ice is another alternative material for blasting processes. If solvent cleaning is used, reduce solvent loss due to evaporation by installing cleaning tank lids or increasing freeboard space in vapor degreasers.

7.4.1.4 Conversion Coatings

Avoid dirtying or soiling the substrate prior to the beginning of the cleaning process. Analyze water for hardness and dissolved solids. Use alkaline cleaners or phosphate compounds with hard water stabilizers where necessary. Use low-temperature, energy-conserving alkaline cleaners or phosphate compounds.

7.4.1.5 Paint Mixing

For small jobs, the amount of paint prepared will often exceed the amount of paint actually applied. Track usage rates for different paint types. Have various sizes of paint

mixing and sprayer cups available to limit over-mixing of paint for a specific project, and to reduce the amount of solvent needed for equipment cleanup.

7.4.1.6 Better Operator Training and Employee Participation

Operators may be very skilled at producing high quality finishes, but poorly trained in minimizing paint usage. Key points for operators include the following:

- **Do not arc the spray gun and blow paint into the air.**
- **Maintain a fixed distance from the painted surface while triggering the gun.**
- **Too much or too little overlap leads to wasted paint and heavy or lightly coated areas. A 50% overlap pattern is typically recommended.**
- **Air pressure should be kept low—this can increase transfer efficiency from 30 to 60 percent.**
- **Keep the gun perpendicular to the surface being painted. Angling the gun leads to some of the spray being too far from your product surface and a decrease in transfer efficiency.**

Ask your operators where they see improvements could be made—after all they work with the equipment daily and may have suggestions not previously thought about. Provide incentives to increase employee participation in whatever waste reduction or recycling program you have. One business tracked the savings in material purchases and money made from recycling activities and put this into a general employee account to be used by the workers to improve their working stations and lunchroom.

7.4.1.7 Maintenance and Use of High-Transfer Efficiency Equipment

Less overspray means fewer air emissions. You can reduce the amount of waste you generate by increasing the transfer efficiency of your coating process. Remember, transfer efficiency is a measure of how much paint goes on the part, compared to how much is sprayed. Typical transfer efficiency from conventional air guns ranges from 20 to 40 percent, thus 60 to 80 percent of the paint is overspray. Overspray is a function of the design and operation of the system used and your operator application techniques.

Talk to your equipment vendor about higher transfer efficiency equipment, and examine the payback period by switching to such equipment. It may be that the amount of material saved will justify upgrading your equipment.

Even if you've examined upgrading your equipment and have decided to continue with your current process equipment, make sure it is in good working order—your painters' performance depends on the condition of their tools. Poorly maintained equipment may result in products that don't meet customer demand and can reduce the transfer efficiency of your operations.

7.4.1.8 Alternative Coatings

VOC emissions are related to the type of coating used and the number of coats necessary for a high quality finish. Acrylic lacquers are typically thinned with solvent by 125 to 150 percent. With synthetic enamels, solvent thinning amounts to 15 to 33 percent. Minimize or eliminate VOC emissions by substituting solvent based paint with waterborne paint, high-solids paint, or with medium or low-solvent paint. Consider, however, the desired final product specifications and the type of product being coated when choosing substitute materials.

7.4.1.9 Proper Cleaning Methods

Wastes resulting from cleaning of the application equipment can be reduced by more efficient cleaning methods. Reduce solvent use in equipment cleaning by scraping paint cups or tanks into a separate container before rinsing the equipment with solvent. Make use of Teflon-lined metal paint containers, which are easier to clean. Use an enclosed gun-cleaning station. Spray solvent through the gun into the cleaning station where it is captured for recovery and reuse. Schedule jobs so that large batches of items of similar color are painted, instead of small batches of custom items, to reduce the amount of dirty cleaning solvent and waste paint generated during change-out.

7.4.1.10 Filters

Suppliers or recyclers of thinners may replace and dispose of dirty spray booth filters for a generator. It is the responsibility of the generator, however, to determine if these filters are hazardous. Filters may be characteristic hazardous waste (toxicity) if they contain enough metals or volatiles. The volatiles could come from the paint thinners used or from the paint itself. The metals typically are found in paint pigments. When cleaning paint equipment (including gun tips and hoses), solvent and/or thinners should not be sprayed on filters (or into the air in the paint booth), as this could cause the filters to become a listed waste (and this act is considered illegal disposal).

Because the filters are in a solid state rather than a liquid, they are not considered a hazardous waste in Kansas due to ignitability (D001). It is important to remember, however, that paint filters have been known to cause trash fires and that some local trash haulers and transfer stations will not allow them to be disposed in the regular trash.

Reusing and recycling can help to reduce waste disposal costs. Wastes may potentially be used as raw materials for a process, or materials may be able to be recovered before being disposed. Recovery technologies can either remove desired materials from a waste stream before disposal or can directly use waste from one process as raw material in another.

7.4.1.11 On-Site Solvent Recycling

Several alternatives are available for recycling solvent on site. Gravity separation is inexpensive and relatively easy to implement by allowing the solvent/sludge mixture to separate under inactive conditions. The clear solvent can then be decanted with a drum pump and used for equipment cleaning, reducing the amount of wash solvent purchased. Reclaimed solvent can be used for formulating primers and base coats, but might create problems if not sufficiently pure.

For those facilities that generate larger quantities of waste solvent, on-site distillation may provide a more cost-effective alternative. Batch distillation of all high-grade solvent wastes can virtually eliminate the need for purchasing lower quality solvents for use in preliminary painting operations and cleanup. An operator may reclaim four and one-half gallons of thinner, with one-half gallon left as sludge from five gallons of paint and thinner wastes. This ratio varies depending on the operations.

When determining the amount of hazardous waste your company generates each month (done to determine which hazardous waste generator category you fall under), remember to count any solvent that enters your distillation/solvent recycling unit, each time it is placed in the unit. So while on-site solvent recycling may help you reduce your waste disposal and solvent purchasing costs, it will not reduce your hazardous waste generation rate.

7.4.1.12 Off-Site Solvent Recycling

Low-volume solvent users, or those who find it uneconomical to recycle contaminated solvents on site, usually send their waste to commercial recyclers for recovery. Commercial recyclers have versatile distillation processes and can handle large volumes and varieties of solvents. Generally, solvent recyclers recover 70 to 80 percent of the incoming spent solvents into reusable products. Recyclers often sell reclaimed solvents back to the user.

In general, suppliers who offer recycling services include the cost of waste collection and recycling in the price of their solvent. This increases the thinner cost, but effectively eliminates separate hauling and disposal or recycling costs. It also reduces the administrative burden on the owner.

Chapter 8 Proper Coating Techniques for Operators

8.1 Introduction

Techniques, which spray painters use during application have a definite effect on transfer efficiency and offer waste reduction potential. Fundamentals of good spray techniques consist of the following:

- ✓ **Proper overlap of the spray pattern**
- ✓ **Proper gun speed**
- ✓ **Proper distance of the gun from the part**
- ✓ **Holding the gun perpendicular to the surface of the part**
- ✓ **Triggering the gun at the beginning and end of each stroke**

Proper overlap of spray patterns will be determined by the coating. Proper overlap may range from 50 percent to 80 percent. Greater overlap may result in wasted strokes, and less overlap may results in streaks

Since the flow of coating from the gun is consistent, the speed of the gun as it is moved across the part should be consistent as well. Steady gun speed will help obtain a uniform thickness of coating. A gun speed higher than manufacturer specifications can distort the spray pattern and not permit the maximum amount of material to reach the surface.

The distance of the gun from the part must be consistent, since, again, the flow of material from the gun is consistent. Generally, this will be six to eight inches for non-electrostatic systems. Spray losses increase with the distance, as does solvent loss. This solvent loss is often corrected by the addition of more solvent. This does not correct the spray loss, and overspray still ends up in the spray booth.

Except for special conditions, the gun should be held perpendicular to the surface of the part. Arcing the gun for hard-to-reach areas wastes material by applying an uneven coat. This also may result in streaks. These areas should be compensated for by changing the positioning of the gun or operator.

If the trigger of the gun is not released at the end of a stroke, the material continues to flow and when the gun changes direction, momentary stopping of the gun results in an accumulation of coating material. To avoid this piling, the operator may spray past the edge of the surface, spraying material into the spray booth and wasting coating.

All manufacturer specifications should be checked to ensure that operators are using the proper technique for their equipment. Operator training and experience will provide operators with knowledge of various painting techniques needed to paint parts of different configurations. Different techniques are helpful when painting inside corners, outside corners, slender parts, round parts, flat parts, large parts, or small parts.

Standard operating techniques will not be fully successful if other problems exist, such as room temperature changing throughout the day (which changes the viscosity of the paint) or if equipment needs repair.

8.2 Conclusion

Operators cannot be expected to compensate for broken gauges, worn fluid tips, or other equipment problems.

Chapter 9 Testing and Inspection of Paints

9.1 Introduction

It is nowadays a welcome change that most of the present day's paint users attach much importance to the choice of paint schemes and the quality of paints, which is revealed by the paints they take in approaching a coating consultant for identifying the choice of paint scheme and in testing the paint materials for maintaining quality. It is very important and critical that the values of the various properties of the paint specified by the buyer is maintained throughout the supplies made by the paint company and the paint is properly applied by the applicator so that the user achieves the expected performance of the coatings.

For this, testing of properties of the coating and inspection of the coating and inspection / monitoring during application of paint is very much necessary. Some of the important properties like volume solids, viscosity, spreading rate and drying time can be determined. The procedures for such tests are given below. No sophisticated instrument is required for these tests. Many critical values can be monitored during the application itself which are also described. Though these do not cover the total specification of the paint, a meticulous monitoring of these properties would ensure a major share of quality control that has a bearing on the performance of the coating later in the machine at the end user's place. This practice of monitoring during application avoids future complications like obtaining higher than or lower thickness than specified thickness that is noticeable after drying.

9.2 Testing Of Paints

Coating materials i.e. paints are formed of two components - volatile and non- volatile;- the former containing organic solvents which evaporate into the atmosphere leaving the non-volatile material which contain the film forming binder material along with pigments and additives, forms the dry film. This liquid paint is a viscoelastic material whose properties of viscosity, volume solids and wet film thickness are interrelated and manipulation or tinkering of one impacts the other.

The ultimate dry film thickness to be obtained after curing of the film is dependent on the wet film thickness and volume solids and the wet film thickness is dependent on viscosity. Hence, before using a paint material, these properties can be very easily determined with least instruments at the site office itself.

A brief description of these properties and the procedure to determine those are described below:

9.2.1. Determination of volume solids: (ASTM D 2697-86)

Before determining the volume solids, specific gravity of the paint is required for further calculations. Specific Gravity measurements are made using a Specific Gravity cup. The cup measures exactly 100 cc and any paint filled in the cup directly provides the specific gravity of the paint based on mass/volume basis. After mixing the two components and before painting, the specific gravity is measured using these cups. For volume solids, an empty Petri dish was weighed (W1) using an electronic balance of 3-digit accuracy. The components 1 & 2 of each paint were mixed as per the mixing proportions of which a small quantity (1-2 gms.) was taken in the Petri dish and immediately weighed (W2). It was spread thinly on the dish and allowed to dry/cure in an air oven maintained at 1050C. At intervals the dish is taken out, cooled in a desiccators and weighed. This procedure is repeated until constant weight is obtained (W3). The value is calculated as follows:

$$\text{Volume solids} = \frac{\text{Volume of paint} - \text{Volume of volatile matter}}{\text{Volume of paint}}$$

$$\therefore \text{Volume solids} = \frac{W_2 - W_1 / \rho_1 - W_2 - W_3 / \rho_2}{W_2 - W_1 / \rho_1}$$

Where, ρ_1 is the density of paint and ρ_2 is the density of solvent used in the paint.

9.2.2. Viscosity

Viscosity, the resistance to flow, is an important property of paints to define by. Most of the pigmented paint materials become 'bodied' materials and exhibit a property called thixotropic property and they follow a flow pattern called thixotropic flow. These viscoelastic properties have a bearing on the paint during its application. They determine the wet film thickness (WFT) and consequently the dry film thickness (DFT) of the applied film. As one of the main constituents of the paint, solvents are added to adjust the viscosity of the liquid paint; the final viscosity of paint at the time of application is to be determined. The WFT of a paint which depends on its viscosity has a relationship with WFT based on the non-volatile matter content of the paint. Hence, viscosity has a direct bearing on the DFT of the paint and by controlling the viscosity during application; the DFT can be monitored during the application stage itself. This is very important from a practical point of view as this monitoring can avoid later complaints and controversies arising due to insufficient or higher than specified thickness of paint films which are difficult to solve at that stage. Efflux type flow cup viscometers are easy to use and more adaptable in the field during application of paints. There are three types of widely used cups namely Ford cup, Zahn cup & Shell cup with different orifice sizes.

Ford cup (of 100 ml capacity with 5 sizes of orifice)

Zahn cup (of 44 ml capacity with 5 sizes of orifice)

Shell cup (of 23 ml capacity with 6 sizes of orifice)

The cup is chosen depending on viscosity of the paint to be tested. For normal viscosity paints Ford cup is used and for highly viscous paints, Shell and Zahn cups with large opening sizes are used. The testing involves filling up of paint under testing followed by opening of the orifice. The time taken for 100 cc of the paint to completely drain from the cup is measured in seconds using a stop watch. In the case of Zahn cup, the bottom is spherical and the volume is 44ml. The result obtained in seconds was converted into poise units using standard tables.

9.2.3. Spreading Rate

Spreading rate, otherwise called Coverage, indicates the surface area that can be covered by one liter or one kilogram of paint. In the laboratory, this is determined by the volume/weight difference before and after applying the paint to a known area [eg. 0.25 sq.m] with paint. The paint company's data sheet specifies a theoretical covering area for each paint value of which is based on the area that the paint can cover if the surface is smooth. But the surface to be painted is not always smooth and depending upon the surface roughness, or the pits and other irregularities present in the surface the actual area that can be covered is less than the theoretical value and also there is lot of material losses during application of paint particularly while spraying, while the loss is minimum when brushing, it is more during spraying. These are taken into account while calculating the requirement or consumption of paint for a particular area. Hence this valuing down is a cumulative effect of the condition of surface, method of application and skill of the applicator.

9.2.4. Drying Time: (ASTM D 1005-95)

A paint film transforms from the state of a wet film to a dry film by the process of evaporation of solvent and also by a chemical reaction among its constituents (in the case of two component air drying systems). During the transformation, it undergoes several changes in its structure. This process of drying has been classified in eight types of drying times such as dry to touch, tack free, hard dry, print free etc.

By having the values of all the properties as described above, the WFT can be monitored during application so that the final appropriate DFT is obtained using the following relationship:

DFT = WFT x Volume solids value in fraction

By monitoring the WFT, all the future values can be monitored and many of the future complications that are likely to arise can be avoided.

9.2.5. Inter-coat adhesion: (ASTM D 3359-93)

When two pack systems like epoxies and polyurethanes are applied, the adhesion to a strict time interval between coats is necessary so that a proper inter-coat adhesion between coatings is obtained. In multi-coat system, when a subsequent coat is applied over an already applied coat, the solvent from the upper coat penetrates the bottom coat and provides inter-coat adhesion between the two coats. This is very essential in the case of multi-coat systems so that there is enough integration between coats ensuring good performance of the total multi-coat system. This penetration of top coat material can be more effective only when the bottom coat is not fully cured when the overcoat is applied. If the bottom coat is allowed to fully cure, it is difficult for the over-coat to penetrate a cured bottom coat leading to poor bonding between coats. This time interval for the next coat is indicated in the specification of individual paint and has to be followed meticulously in order to get the best performance from multi-coat systems.

9.3. Conclusion

All painting materials including primers, thinners, and paint components are to be procured directly from the manufacturer or their authorized selling agents only. Each item of the procurement MUST be accompanied by Quality certificate from the Manufacturer in ORIGINAL and are to be offered to Inspection for verification. All painting is to be carried out following the standard procedure laid out in the documents and / or the manufacturers specified procedure. All paints procured for application must be accompanied by documents detailing the application procedure.

Painting works shall be under constant monitoring from Inspection, and stage wise inspection shall be offered FOR FOLLOWING SPECIFIC STAGES:

Surface preparation

Primer Application

Each coat of painting

***Note:* Any shop painting already applied should be recorded**

Each inspection shall be documented and at the end of the job, submitted to inspection Department.

Any defect, deviation detected during inspection shall be rectified to the full satisfaction of Inspection.

General Inspection Guidelines:

Check for:

The Paint **Manufacturer Certification**

Manufacturing date and Expiry date

General health of the packing

Correctness of specification

Surface **Cleanliness of the subject surface**

Surrounding area to ensure non-contamination during or just after application

Surface cleaning equipment and procedure with due consideration to safety

Proper surfaces after preparation free from all loose particles

Proper cleaning of nooks & corners and difficult to access location

Application **Proper time lag from surface preparation to application**

Proper mixing (for two pack system)

Correct application tools, procedure and skill

Uniformity of wet film thickness per coat

Proper inter-coat time interval

Adequate post drying hardness

Annexure 1

List of Indian Standard for painting procedure for Machine Tools & other related standards

SL. No.	Reference	Description
1	IS 10949-84	Painting Procedure for Machine Tools
2	IS 101 P1/Sec2	Methods of Sampling Paints – Preparation of samples for Testing
3	IS 101 P7/Sec1	Environmental Test on Paint Films – Resistance to Water
4	IS 101 P7/Sec4	Environmental Test on Paint Films – Resistance to Bleeding of Pigments
5	ASTM D 1654 - 92	Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
6	ASTM D 3170 - 87	Standard Test method for Chipping Resistance Of coatings
7	ASTM D 5178	Standard Test Method for Mar Resistance of Organic Coatings
8	IS 101 P 6 / Sec : 1	Method of test for paints Resistance to humidity
9	IS 10949-84	Gray Surfacer
10	ASTM D 2247 - 94	Standard practice for Testing Water Resistance of Coatings in 100% Relative humidity
11	ASTM D 4518	Standard Test Methods for Measuring for Static friction of coating surfaces
12	IS 10949-84	Gray Putty Cellulose Base
13	IS 101 P7/Sec3	Environmental tests on Paint films – Resistance to Heat
14	IS 10949 –84	White Surface Primer
15	IS 101 P6/Sec3	Durability tests on Paint Films – Moisture, Vapour, Permeability.

16	IS 101 P6/Sec4	Durability tests on Paint Films – Degradation of Coatings by Pictorial aids.
17	IS 101 P6/Sec 1	Method of of Neutral salt Spray Test.
18	IS 101 P5/Sec3	Mechanical Test for Paints – Print free Test
19	IS 101 P5/Sec3	Mechanical Test for Paints – Impact Resistance (Method A)
20	IS 101 P5/Sec3	Mechanical Test for Paints – Impact Resistance (Method B)
21	ASTM D 3363 -92	Test Method for Film Hardness by Pencil Test
22	ASTM G 53 - 95	Standard practice for operating light and water exposure apparatus (Fluorescent UV condensation type) for exposure of nonmetallic materials.
23	ASTM G 85 - 94	Standard Practice for Modified salt spray (Fog) testing
24	ASTM D1640 - 83	Standard Test Methods for Drying, Curing or Film formation of organic coatings at room temperature
25	ASTM D 3359 - 93	Standard test method for measuring adhesion by tape test Method "A"
26	ASTM D 2247 - 94	Standard test method for water resistance
27	ASTM D 3964 - 80	Standard practice for selection of coating specimens for appearance measurements
28	ASTM D 4138 - 94	Standard test methods for measurement of dry film thickness of protective coating systems by destructive means
29	ASTM D 4039 - 93	Standard test method for reflection haze of high-gloss surfaces
30	ASTM D 4541 - 93	Standard test method for pull-off strength of coatings using portable adhesion testers
31	ASTM D 3359 - 93	Standard Test Method for Measuring Adhesion by Tape Test – Method B - Cross cut tape test.
32	ASTM D 3891 - 90	Standard practice for preparation of Glass panels for testing Paint, Varnish, Lacquer and Related products

33	ASTM D 4366 - 94	Standard test methods for Hardness of Organic Coatings by Pendulum Damping Tests.
34	ASTM D 2134 - 93	Test Method for Determining the Hardness of Organic Coatings with Sward – type Hardness Rocker.
35	ASTM D 4212 - 93	Standard test method for Viscosity by Dip – type viscosity cups.
36	ASTM D 3322 - 82	Standard practice for testing Primers and Primer surfacers over Preformed metal
37	ASTM D 4060 - 90	Standard test method for Abrasion resistance of Organic coatings by the Taber abraser.
38	ASTM D - 3276	Inspection standard for painting

Overview of Paint shops in some of the repute Machine Tool Industries

1

Jyoti has established its own paint shop which is fully automated and it comprises of 7 tanks pre-treatment process followed by CED primer coating and conveyorized backing with powder coating booths. There are 4 powder coating booths in line of different colors.



Versatile paint shop which will deliver sheet–metal components duly powder coated / painted with CED primer coating and castings will be delivered with CED primer coatings and followed by backing.

==

2

Ace has established an environmentally friendly paint shop for pre-treatment and powder coating sheet metal to ensure longevity and aesthetic appeal of the products.

The shop consists of:

- **Fully automated PLC controlled 7 tank process system with conveyors**
- **Amada Bending and shearing machines**
- **Fully automated powder coating equipment with a conveyor systems capable of varying speeds suit the complexity and size of the sheet metal**

Annexure 3

List of Paint Testing Equipment		
1	**Coating Thickness Meter**	**DETERMINATION OF FILM THICKNESS.**
	ISO 2808: PAINT AND V ARNISHES.	**ISO 19840: CORROSION PROTECTION OF STEEL STRUCTURES BY PROTEC TIVEPAINT SYSTEMS.**
		**MEASUREMENT OF, AND ACCEPTANCE CRITERIA FOR, THE THICKNESS O F DRYFILMS ON ROUGH SURFACES**
		The Paint Test Equipment Coating Thickness Meter easily measures all coatings on metallic substrates using the magnetic induction or eddy-current principles, ensuring the correct coating thickness has been applied.
		It is one of the most advanced Coating Thickness Meters on the market, using up-to-date technology in a robust portable instrument and incorporating all the following user functions through a menu-driven back-lit display.
2	**Gloss Meter**	**DETERMINATION OF SPECULAR GLOSS OF NON-METALIC PAINT FILMS AT 20 DEGREES AND 60 DEGREES.**
	ISO 2813: PAINT AND V ARNISHES.	**Gloss and Haze measurement is essential where an aesthetic appearance of the coating finish is required and to ensure uniformity of the surface finish.**
		
3	**Calibration Foils**	**Calibration Foils are required for the calibration of Coating Thickness Meters.**
		**Each individual Calibration Foil is measured in the centre and the value is printed on the attached label.**
4	**Holiday Detector**	**CORROSION PROTECTION BY PROTECTIVE PAINT SYSTEMS.**

	ISO 29601: PAINTS AND VARNISHES.	**ASSESSMENT OF POROSITY IN A DRY FILM.**
		**ISO 2746: VITREOUS AND PORCELAIN ENAMELS.**
		ENAMELLED ARTICLES FOR SERVICE UNDER HIGHLY CORROSIVE CONDITIONS.
		HIGH VOLTAGE TEST.
		The Holiday Detector is a DC voltage Holiday Detector for detecting pinholes and flaws in insulated coatings on conductive substrates.
		Where coatings have to provide an effective safeguard against corrosion, it is essential that any pinholes or flaws that will eventually lead to corrosion are detected at the earliest possible stage, preferably immediately after the coating application.
		The test voltage is of high impedance, enabling safe testing, and does not damage or cause burn marks to the coating.
		Operation is by the test voltage being applied to the coating by moving a brush electrode across the surface and where there is either a pinhole or flaw, the voltage will spark through the coating, a red indicator will flash and an audible alarm will sound.
		The detected flaw can be marked for subsequent repair, and testing resumed for the remaining surface area.
5	**Pinhole Detector**	**ASSESSMENT OF POROSITY IN A DRY FILM.**
	ISO 29601: PAINTS AND VARNISHES.	**ISO 8289: VITREOUS AND PORCELAIN ENAMELS.**
		**LOW VOLTAGE TEST FOR DETECTING AND LOCATING DEFECTS.**
		The Pinhole Detector uses the wet sponge principle to detect through-pinholes, cracks and damaged areas on non-conductive coatings on conductive substrates.
		These flaws would eventually lead to corrosion and premature failure of the coating.
6	**Broad Brush**	**Brass-filled Brushes for the testing of coatings on large flat areas using the Holitech Holiday Detector.**
		

7	Circular Brush	Brass-filled Circular Brushes for the testing of coatings on the internal diameter of pipes using the Holitech Holiday Detector.
		
8	Rolling spring	3/4" phosphor bonze Rolling Spring for the testing of coatings on the external diameter of pipes using the Holitech Holiday Detector.
		
9	Circular Sponge	Circular Sponges for the testing of coatings on the internals of pipes using the Pintech Pinhole Detector.
		
10	Adhesion Tester	ISO 16276- 1: CORROSION PROTECTION OF STEEL STRUCTURES BY PROTECTIVEPAIN T SYSTEMS.
	ISO 4624: PAINTS AND VARNISHES.	ASSESSMENT OF, AND ACCEPTANCE CRITERIA FOR , THE ADHESION/COH ESION (FRACTURE STRENGTH) OF A COATING.

	PULL- OFF TEST FOR ADHESIO N.	**PART 1: PULL-OFF TESTING.**
		**The Adhesion Tester is one of the most accurate and versatile adhesion testers currently available.** **It measures the adhesion bond strength of applied coatings with ease and precision.** **The adhesion is measured by the tensile pull on a Dolly glued to the coating surface.** **The force is applied through the centre of the Dolly by a hydraulically loaded pin.** **This ensures an exactly central point-loading of the force.**
11	**Cross Hatch Cutter**	**ISO 16276- 2: CORROSION PROTECTION OF STEEL STRUCTURES BY PROTECTIVEPAIN T SYSTEMS.**
	ISO 2409: PAINTS AND VARNISHES.	**ASSESSMENT OF, AND ACCEPTANCE CRITERIA FOR, THE ADHESION/COH ESION (FRACTURE STRENGTH) OF A COATING.**
	CROSS-CUT TEST.	**PART 2: CROSS-CUT TESTING AND X-CUT TESTING.**
		**The Cross Hatch Cutter is a multi-blade cutting tool which enables an assessment to be made of the adhesion resistance of coatings to separation from substrates when a right-angled lattice pattern is cut into the coating and penetrates through to the substrate.** **The coating thickness determines the Cutter size used.** **The 1mm Cutter is suitable for coatings under 60 microns. The 2mm Cutter is suitable for coatings over 60 microns.**
12	**Flat Adhesion Dolly**	**Stainless Steel Adhesion Test Dolly for flat surface testing using the Hate Adhesion Tester.**
		

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- ***All the information and data are given in good faith.***
- ***IMTMA is not responsible for accuracy and current validity; user to check with relevant sources for latest information.***

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