Day 1

Specification: A document defining ***what*** is wanted and ***what*** shall be done to achieve this.

Procedure: A detailed description of ***how*** to perform the tasks called for in the specification.

Specification ---- "what" to do.

Procedure ---- "how" to do.

Coatiog system specification

- Area
- Substrate
- Surface preparation
- Coating system

Coting work spedification

- Coating system specification
- Procedure

Standard: Definitions and procedures made by third party authority used as a common reference.

Why do we use standards

- Uniform understanding
- Normative procedures and equipment
- Rationalisation of production

- Avoidance of discussions

Five levels of standards

- Company standards
- Industry stardards
- National stardards (BS ,DIN,ASTM)
- Regional standards (CEN)
- International standards (ISO)

Quality assurance (QA): Implementation of all the systematic and planned actions necessary to ensure that a product or service is delivered is the required quality.

Quality control (QC): Checking of indivdual operations to ensure conformity with the specifications.

One of the actions in QA

Surface treatment inspector inspection phases

- Before surface preparation
- Surface preparation
- Before paint applications
- Paint application
- After paint application

Inspector duty

- Observe , monitor
- Advice

- Check
- Report
- Stop of work requires (given authority)

How to perform

- Technically authoritative
- Flexible (within the limits of specifications)
- Well behaving /diplomatic

Why use coating

- Protection
- Signal ownership, company colour, image
- Warning, attention
- Ease of cleaning

Substrates

- Steel
- Non-ferrous metals
- Concrete
- Wood
- Plastics

Coatings

- Paint
- Metallizing
- Glass

- Powder coating
- Wax coating (soft coating)

Considerations

- Substrate
- Environment
- Surface preparation
- Coating quality
- Coating type
- Paint application
- Paint film thickness

Day 2

Surface preparation: The process making a surface suitable for application of a coating.

Increase adhesion – long term

- Removal of contaminants (cleanliness)
- Increase of contact area (anchor pattern)

Contaminants ---*General*

- Dust
- Oil/grease
- Moisture
- Salt ----Osmosis
- Non-intact, old coating

Contaminants ---*Substrate*

- Millscale ---steel (battary), St2,St3 have millscale.
- Red rust ---steel
- White rust ---galvanizing, zinc coating
- Laitance ---concrete

Methode for removal (ISO8504)

- Chemical
- Thermal
- Mechanical

Chemical methods

- Water (<700bars) ---soluble salts
- Alkaline solutions ---grease (not minaral oil)
- Emulsifying solutions ---oil, grease
- Solvents ---oil, grease
- Pickling (acid treatment) ---millscale, rust
- Electrolytic descaling ---rust
- Phosphatizing ---protective layer, adhesion, promoter, phosphate layer, protect corrosion

Thermal methods

- Flame cleaning ---millscale, rust, oil

Mechanical methods

- Needle gunning, chipping ---rust
- Grinding (ISO8501) ---rust, old coating
- Wire brushing ---rust, old coating (not millscale)
- Sanding ---rust, old coating (roughening)
- Abrasive blasting ---millscale, rust, old coating
- Water jetting ---rust, old coating (does not roughening)

Sequence of cleaning

1. Oil, grease ---emulsifying solutions
2. Soluble salts ---water hosing, water jetting
3. Millscale ---blasting, sanding, water jetting, etc.

4. Dust ---blowing, vacuum cleaning
5. Moisture ---heating

Methods –relative durability, C-steel

- No preparation ---------
- Flame cleaning ----------
- Power tool ----------
- Blasting ----------
- Water jetting ----------

Standards

- Cleanliness ---ISO8501-1
- Contaminants ---ISO8501-1, ISO8502
- Methods ---ISO8504
- Roughness characteristics ---ISO8503
- Water jetting ---SSPC –SP12/ NACE5

Equipment for abrasive blasting

- Centrifugal force ---wheel abrator
- Pressurized air (open blasting)

Wheel abrator –characteristics

- Almost exclusively on line
- Typically arranged insets ---2, 4, …
- Low to medium roughness

Wheel abrator –what to look for?

- Result
- Refill frequency
- Type and mix of abrasives
- Synchronizing of wheel abrators

Nozzle –choracteristics

- On-site
- Versatile
- High roughness possible (pressure, distance)

Nozzle –what to look for?

- Result
- Oil
- Water

Nozzle –variants

- Dry
- Wet
- Vacuum

Abrasive –types

- Metallic
- Non-metallic

  --*Mineral*

  --*Organic*

--*Others*

Abrasives

- Grir ---angular
- Shot ---round
- Wire cut ---cylindrical

Metalloc

- Chilled iron grit
- High-carbon, cast steel grit/shot
- Low--carbon, cast steel shot
- Wire cut

Non-metallic

- Natural minerals

  Garnet, Olivine, Stauralite

- Synthetic minerals (slags)

  Copper slag, Nickel slag, Coal furnace slag, Iron furnace slag, Glass,

  Aluminium oxide

- Organic

  Ground walnut shells

  Ground cherry stones

- Other

  CO2 ice, Baking soda (NaHCO3), Plastic granulates

Surface characteristics for abrasive blasting

- Profile ---sharp or dimpled
- Roughness ---high or low
- Density ---high or low

Ry5 : Mean of five max. Peak to valley measurements in five adjoining sampling length

Ry5 = 1/5 (Ry①+Ry②+Ry③+Ry④+Ry⑤)

Ry (Rmax.) : Max. Distance peak to valley in sampling length

Rz : Rz = 1/5 (y1+y2+ …+y9+y10)

Rz velue near Ry5

Ra : Ra * L = (Area above + Area below)

Summary

- Ry > Rz
- Ry5≈Rz however, 5 and 1 sampling length respectively
- Rz >> Ra Rz≈6 * Ra
- Roughness ---increased area
- Area increase (%)≈0.9 *Rz (micron)

Density : Number of peaks above the arithmetical mean line per unit length

! Peaks exceeding a chosen minimum

Assessment for surface characteristics

- Profile ---visual

- Roughness ---comparator (Testex)
- Density ---stylus

Comparator

- ISO Comparator (Grit and shor) ---means for Ry5
- Rugotest NO.3 (Grit and shot) ---Ra
- Testex ---Ry
- Needle gauge ---Ry5

Day3

Paint : A liquid material which can be applied on the substrate.

Why use paint?

- Protection (the main funtion)

Steel and other metals ---against corrosion

Wood ---against rot / decay

Concrete ---against carbo

Other valuable structures ---against…

---fouling (ships underwater areas)

---contamination of commodities (cargotanks)

---abrasion (ships decks)

- Decoration
- Warning / safety
- Comouflage
- Image

Composition for paint

- Binders
- Pigments
- Extenders
- Solvents
- Additives

Binders ---characteristics

- Non-volatile part
- Adhesion
- Cohesion ---strength of the paint
- Paints prominent properties

Examples for binders

- *Bitumen, tar*
- *Chorinated rubber, Acrylic, Vinyl*
- *Silicone, Silicate*
- *Alkyd, Modified alkyd*
- *Epoxy, Polyurethane*

Pigments ---characteristics

- Non-volatile part
- Colour
- Opocity (hiding power)
- Other functional properties

Examples

- *Prime or hiding (white)*
- *Black*
- *Other coloured, Organic and inorganic*
- *Metallic*

Extenders ---characteristics

- Non-volatile part
- Mechanical strength
- Application properties
- Cost reduction

Example

- *Corbonates, Silicas, Silicates*

Solvents ---characteristics

- Volatile part
- Dissolution (liquification) of binder
- Application properties
- Drying time
- Flash point

Example

- *Hydrocarbon*

  ---*Aliphatic (white spirits)*

  ---*Aromatic (naphtha, toluene, xylene)*

- *Oxygenated*

  ---*Alcohols (n-bulanol)*

  ---*Ester (n-butyl acetate)*

  ---*Ethers (monoethyl, ethylene, glycol)*

  ---*Ketones (MEK, MIBK)*

Type	Example	Resin
Aliphatic	White spirit	Alkyds
Aramatid	Toluene, Xylene	CR, Vinyl
Alcohols	Ethanol, Butanol	Zinc ethyl silicate Epoxies
Ketones	MEK	Epoxies
Acitates	Ethyl acetate Butyl acetate	Epoxies, Polyurethane

Examples for additives

- Anti-settling, anti-skinning agent
- Driers
- Plasticizers
- Wetting agent, coalescing agents
- Preservative, fungicides

Production for paint

1. Raw (materials)
2. Premix (millbase)
3. Dispersion (grinding)
4. Final mix (binder, solvents, additives let down)
5. Filling and packaging

Dispersion stage ---Grinding (wetting of agglomerates)

- *High speed disperser: up to 3600 liters/batch*
- *Dynomill: up to 1500 liters/hour*

Generic type : A member of a family with properties distinct from other members of the family. ---binder decide paint property

- Physically drying
- Chemically curring
- Oxidatively curing

Physically drying (solvent borne)	
Common properties	Generic type
• Thermoplastic • Reversible • Solvent sensitive • Excellent recoatability • Temperature independent for film formation	Bitumens, Tars, CR, Acrylic, Vinyl,

Physically drying (water borne)	
Common properties	Generic type
• Thermoplastic • Reversible (to a certain degree) • Solvent sensitive • Excellent recoatability • Temperature independent for film formation	Acrylic copolymer, Styrene-butadiene copolymer, Vinyl acetate copolymer, Vinyl chlorinated copolymer,

Chemically curing		
Common properties	Generic type (solvent borne)	Generic type (water borne)
• Non-thermoplastic • Irreversible • Resistant to solvent (own) • Critical recoating interval • Temperature dependent for film formation	Epoxies, Polyurethane, (one or two-pack) Zinc-silicate, Silicones, Polyesters (hempel 3592),	Epoxies, Zinc silicates,

Oxidative curing (Solvent-borne and water-borne)	
Common properties	Generic types
● Generally similar to chemically curing paint ● Poor alkali resistant	Oil based, Oleoresinous, Alkyds, Multified ---epoxyester

Physically drying

- Solvent-borne ---binder ∽∽∽∽
- Water-borne ---binder globules ●●●●

Pot life : Maximum time, at a given paint temperature, the mixture of base and curing agent should be used after mixing.

Induction time : Minimum time, at given paint temperature , necessary to allow pre-reaction of the components for optimum film formation.

Minimum temperature for film formation	
Physically drying (solvent borne)	-10℃
Alkyds	5℃
Epoxy (in general)	10℃
Polyurethane	-10℃
Water borne	5℃
Zinc silicate (solvent borne)	-10℃

Application must give the paint film the following properties:

- Durability in service environment
- Protection of substrate for suitable peried
- Formation of coherent film with low permeability to substrate
- Impact and mechanical resistant

Brush

- Good penetration
- Cheap
- Slow
- Uneven films (brush marks)

Roller

- Poor penetration
- Cheap
- Slow
- Very thin and uneven films

Checklist for application of paints

- Stirring /mixing /thinning
- Correct wet film thickness
- Adequate ventilation
- Temperature limitations
- Avoidance of too high RH
- Good workmanship
- Safety, health and environment

Chicklist application of 2-pack paints

- Correct mixing of components
- Mechanical mixing
- Induction time

- Minimum and maximum overcoating times
- Pot life
- Curing time
- Temperature limitations during application and curing

Loss factors during application

- Wind [> 2m/sec (7.2km/h) –inadvisable to apply by spray]
- Application method (e.g. spray, brush, roller)
- Surface profile (dead volume)
- Access (e.g. narrow spaces, long distances)
- Design
- Equipment (e.g. nozzle size, gun)
- Left in can or equipment

Day4

Corrosion : A *degradation* of a *metal* through *interaction* with the *environment.*

Galvanic series

Noble

C (graphite)

SS (passive)

Cu

Millscale

SS (active)

Fe

Zn

Mg

Ignoble

Type for steel

- Mild steel, carbon steel
- Cast iron
- Corten steel
- Stainless steel

All can corrode

Corrosion for steel (in air)

- Relative Humdity

- Dirt, dust
- Salt, sulfur dioxide

Steel + Air (Oxygen) + Water → Rust

Corrosion for steel (in water)

- Air, oxygen
- Salinity of water
- Non-alkaline water

Steel + Air (Oxygen) + Water → Rust

Steel + Oxygen + Water ---mechanism

Steel + Acid → Iron salt + Hydrogen

Steel + "Other metal" ---Zinc, Copper

- Corrosion product +groove
- Water + salt ---Electrolyte

Design –Avoid

- Dirt / dust traps
- Water traps
- Combination of metals, without insulation

Corrosion types

- General / Uniform corrosion
- Galvanic / Bimetallic corrosion
- Pitting corrosion
- Crevice / Deposite corrosion

- Erosion / Turbulence corrosion
- Selective / De-alloying corrosion
- Stress corrosion cracking
- Microbiologically induced corrosion

G / U : Even corrosion spread all over the substrate of the corroding metal. Reduction of metal thickness at a slow and constant rate evenly over the surface.

G / B : Direct contact between two metals having different electrical potentials in an electrolyte.

Intensity of attacks depends on:

- *Difference in electrical potential*
- *Relative area sizes of anode and cathode*
    1. *A small cathode will not offect a large anode very much (General corrosion)*
    2. *A large cathode will affect a small anode very much (Pitting corrosion)*

May be reduced through:

1. *Insulation*
    - *Non-metallic washers*
    - *Gaskets*
    - *Barrier coatings*
2. *No combination of metals for apart in detention*

3. Design

Pitting : Attacks are inform of localised holes often filled with corrosion products. Rate is often accelerated ,causing rapid perforation.

Pitting corrosion on passivated metals:

- Certain alloys will appear on two different levels in the galvanic series. We call these the active (least noble) and the passive (most noble) phases.
- This is due to the oxide film being wholly or partially absent, or to shielded areas with low content of oxygen.

C / D

May be reduced by:

- Welding instead of flanges / gadkets
- No sharp edges
- Good drainage
- Rubber or teflon washers
- Avoidance / removal of deposits

S / D : Attacks in the form of removal of least noble element from a solid alloy.

Such as :

- De-zincification of brass ---Red (yellow) =brass
- Graphitation of cast iron (steel) ---Black (grey) =cast iron (steel)

Stress corrosion cracking : Attacks in the form of premature cracking of

metals in certain environments. It is a combined action of corrosion and surface tensive stress.

Most prone are:

- Stainless steels in sea water
- Copper alloys in ammonia
- Carbon steel in nitrate solutions

E /T

Attacks through

- High flow velocities of liquid
- Abrasive action of solid particles in liquids or gases

Manifestation

- Grooves, gullies, rounded holes and valleys without corrosion product

Anticorrosive coating

Principles of function

- Prevent electron release from iron
- Prevent –ions to move
- Prevent access of water

Different ways

- Barrier protection ---“water”
- Inhibitive protection ---“-ions”
- Galvanic protection ---“electrons”

Barrier

- Low water absorption
- High DFT
- Dense films

Tar, Coal tar

Inhibitive

- Special pigments

Zinc phosphate

Galvanic

- Primer containing metal less noble than iron

Zinc, Aluminium

Typical system

- Barrier type only
- Inhibitive plus barrier
- Galvanic only
- Galvonic plus barrier

Day5

Shopprimer : Temporary protection during storage and fabriation. Also termed as *pre-fabrication primer*.

Characteristics for shopprimers

- Line applied
- Fast drying ---follows contour of surface
- DFT: 15-25μm ---measureed on smooth plate
- Protection time: up to 1 year ---DFT and type depending

Type for shopprimers

- Binder ---Silicate, Epoxy, (PVB)
- Pigment ---Zinc, Iron oxide, Zinc phosphate

Shopprimers –line application

Checking raw plate

- Take water out
- Blasting
- Clean plate

Check blasting

- Application

Checking application (gun speed, plate speed ..)

- Drying

Checking applicated

Blst / Holding primers :Temporary protection during execution of paint work.

Blast primer : Protection of blasted steel.

Holding primer : "Upgrading" of old shopprimer.

Characteristics for Blast / Holding primers

- Manually applied
- DFT: 30-50 µm
- Protection time: 2-3 months

Type for Blast / Holding primer

- Binder ---Epoxy
- Pigment ---Zinc phosphate

Wash primers : Adhesion primer to zinc and aluminium. Also termed as "*Etch primer*".

Characteritics for wash primers

- Require super clean surface (degreasing, steam cleaning)
- Contain phasphoric acid
- DFT: 5-10 µm

Type for wash primers

- Binder ---PVB
- Pigments ---Zinc chromate

Zinc rich paint

- Pigment ---Zinc
- Binder ---Silicate (inorganic)

  Epoxy (organic)

  Polyurethane (organic)

  Epoxy similar to polyurethane

Zinc level for zinc rich

- SSPC (inorganic) ---74%
- SSPC (organic) ---77%
- ISO12944 ---80%
- BS5493 ---90%

Characteristics for zinc silicate

- Excellent rust protection ---rust creep, galvanic
- Excellent resistance :
  - *Heat*
  - *Solvent*
  - *Water (0.1-0.6 µm/ 1 year)*
  - *Wear*
- One coat ---100µm (65 µm as primer, lewest 55µm)
- Surface preparation ---High cleanliness, high and sharp roughness
- Application ---DFT < 200 µm (prevent crack)
- Curing ---RH > 50% (at surface)

- Overcoating ---Fully cured
- Overcoating ---Mist coat (popping)
- PH value ---6 to 9

Characteristics for zinc epoxy

- Surface preparation ---less demanding than zinc silicates
- Application ---DFT < 50 μm
- Overcoating ---As for epoxies, no popping
- Heat resistance ---As epoxies, 150℃
- Wear resistance ---low
- PH --- 6 to 9

Metallization : Application of a protective metallic coating on a substrate –often steel and steell allays, but also possible on wood, plastic, concrete.

Metallic coating

- Zinc, alloys
- Alainless alloys
- Stainless steel
- Titanium
- Others

Application method

- Electrodeposition ---galvanizing (zinc)
- Dipping ---hot dipped galvanizing
- Spray ---thermal spray

Electrodeposition

- Zinc
- Chromium
- Nickel

Very thin coats

Hot dipped galvanizing –"Dry" process

- Degreasing ---FWW (fresh water washing)
- Pickling ---FWW
- Fluxing
- Dipping

Hot dipped galvanizing –"Wet" process

- Degreasing ---FWW
- Pickling ---FWW
- Dipping

Flux agent on top of zinc melt

Characterististics for hot dipped galvanizing

- Fe 5%-25% ---Unkilled 75µm-100µm (shiny, roses)

  Killed –200µm (matte)
- Good adhesion ---metallic bonding
- Even DFT
- Limitations in size

Principle for thermal spray

1. Metal
2. Heat
3. Velocity (Kinetic energy)
4. Impact and solidification
5. Lamellar

Types for thermal spray

- Heat source
- Combustion ---flame spray (2000-3000℃)
- Electrical arc ---arc spray (5000-6000℃)
- Plasma ---plasma spray (10000-25000℃)

Flame spray

- Metal: wire or power ---Al, Zn, Zn/Al, Al/Mg, Fe, Fe/Cr
- Gas: acetylene, propane

Arc spray

- Metal: wire ---Al, Zn
- Voltage,current: 20-40V, 100-500A

Plasma spray

- Metal: power ---Ti, Fe/Cr, Ni
- Plasma: from H2, He

Characteristics for thermal spray

- Surface preparation ---Excellent steel work, Sa3, Coarse(G)

- Application ---200-400μm, special skill
- Curing ---No need
- Overcoating ---Al, Al alloys:

  Always > Duplex
- Service ---predictable, long term

Day6

Wet film

µm * m^2 = µm^3

1µm^3 =(1/1000)Ltr

1. Wet volume (Ltr) = WFT (µm) * A (m^2) / 1000
2. Dry volume (Ltr) = DFT (µm) * A (m^2) / 1000
3. VS(%) = Dry volume (Ltr) * 1000 /Wet volume (Ltr)

   =DFT (µm) * 100 / WFT (µm)

Consumption

Given: DFT (µm), A (M^2)

Required: How much paint? Theoretically …

TC = WFT (µm) * A (m^2) / 1000

=DFT (µm) * A (m^2) / VS(%) * 10

Spreading rate

Given: DFT(µm), A (m^2)

Required: How many m^2 per litre, theoretically …

TSR (m^2 / litre) = A (m^2) / TC (ltr) = VS(%) * 10 / DFT (µm)

Practical *vs.* Theoretical

- Consumption is higher
- Spreading rate is lower
  1. *DFT distribution*
  2. *Overspray*

3. *Left overs*

Practical consumption

PC (Ltr) = CF * TC (Ltr)

Note: CF > 1

Practical spreading rate

PSR (m^2 / Ltr) = LF * TSR (M^2 / Ltr)

Note: CF < 1

LF = 1 / CF

Loss (%) = (1-LF) * 100

1 Mil = 1 inch /1000 = 25.4 µm

Composition for concrete

- Binding medium ---cement + water (hydration)
- Aggregates ---sand + stone +gravel
- Addtives ---

Hydration : Reaction of water with cement necessary for setting and densifying concrete (*curring mechanism*).

Characteristics for concrate

- Relatively high compressive strength (15-40 MPa)
- Porous
- Alkaline (PH 12-13)
- Low tensile strength ---reinforcing steel bars (rebar)

Typical defects

- Blow holes (bug holes) ---Small, reglar or irregular holes formed due to air bubbles entrapped during placement and compaction.

  ---Usually not exceeding 15 minutes.

- Cracks
- Laitance : Loose cement and aggregate fine on surface.
- Form oils : Petroleum oils, waxes or silicones
- Efflorescence : 1. White crystalline deposits on surface of concrete;

  2. Leaching of lime or clcium;

  3. Reaction with CO2 inside.

Common forms of deterioration

- Carbonation : 1. Carbon dixide + water;

  2. Weak carbonic acid + alkaline compounds;

  3. PH < 9;

  4. Break down of protective pasive layer on steel rebar and consequent crossion

  5. Cracking

Attack is from outside to inside concrete

- Chemical ---Chlorids
- Organic ---
- Freeze / thaw cycle ---Liquid
- Mechanical ---Abrasion, erosion

Surface preparation

- Clianing ---removal of oil / grease
- Roughening ---Acid etching

  ---Abrasive sweeping

  ---Power tool

Requirements to painting

- Fully cured --- 28 day (normal portland cement)
- Moisture content --- 4% W/W (less than)

  ---Plastic sheet method (ASTM)

  ---Moisturemeter
- Soundness (surface strength) ---1.4 to 2.1Mpa (depend on conditions)

Marine fouling

- Bio-film
- Larvae and spores
- Barnacles (e.g. Acom, goose)
- Tubeworms
- Algae (e.g. seaweed, grass)

Toxing

- Cuprous oxide
- Tributyl tin
- Biocides (various)

Arsenic, mercury (previously), organic, toxics

Functional types

- Conventional (soluble matrix rosin)
- Release (insoluble matrix)
- Ablative (rosin + moderators)
- Self-polishing (co-polymer)

TBT containing

TBT free

- Low surface contact (self-release)

One of three will happen

1. TBT-polymer type will be replaced by new co-polymer type (CuO**x** / Zn / silyl)
2. Low surface contact types (self-release) will come more to the fore
3. Dry-docking intervals may be shorted

Fouling

= increased roughness

- Friction increase
- Drag increase
- Increased resistance
- Increased bunker
- Consumption or reduced speed

Powder coating

- Sintering

Day8

Xylene

- Discolour ---Physically
- No reaction ---Chemecal
- Lifting ---Oxidative

Place flake into solvent (various) (MEK)

- Flake dissolves ---Physically
- Flake wrinkles ---Oxidative
- Flake unchanged ---Chemecal

Run (curtain, sagging)

Caused by

- Gun too close
- Too much paint (slow pass)
- Excess thinning
- Surface too hard /clossy
- Surface temperature too high
- Surface temperature too low

Remedied by

- Brush out before dry / cured
- If dry / cured, abrade / wash or blast
- Apply fresh coat

Open film

(Applied coat appears as drops in discontinuous film exposing under lying coat)

Caused by

- Too high atomization
- Gun too far from substrate
- Paint too viscous
- Too high surface temprature
- Too high air temperature

Remedied by

- Application of one additional, heavy coat with addition of thinner to improve flow.

Orange peel (hills and valleys in film resembling skin of orange)

Caused by

- Paint too viscous
- Gun too close
- Too fast solvent evaporation
- Too low air pressure

Renedied by

- Brush out before dry / cure
- If dry / cure, abrade / wash or blast
- Remedy spray conditions

- Apply fress coat

Wrinkling and orange peel (frequently found together)

Dryspray (over spray)(Dry flat pebbly suface, resembling sand paper)

Caused by

- Gun too far away
- Too high atomization
- Incorrect spray technique
- Fall-out from adjacent spray
- Fall-out from wind
- Too high air temperature

Remedied by

Remove by dry brushing and solvent wipe before dry / cure

Cratering-ponholes

Wet intermediate coat with evaporation of solventor air

Pinholes (tiny, deep hole)

Caused by

- Solvent / air passage through the film

Remedied by

- Brush out and apply additional coat if not dry / cured
- If dry / cured, abrade / wash or blast and apply fresh coat

Cratering (small unifoem indentations in film)

Caused by

- Air / solvent, gas

Remedied by

- Abrading / washing plus fresh coat (small areas)
- Blasting (large areas)
- Application of additional coat(s)

Fish eyes

(Separaion of pulling apart of wet film to expose substrate or preceding coat)

Caused by

- Substrate contaminated by

  ---oil (grease)

  ---silicone

  ---dirt

Remedied by

- Blasting plus removal of contaimination

Blistering

(Small to large broken or unbroken bubbles)

Caused by

- Solvent entrapment
- Salt (or oil / moisture)

- Contamination on the substrate giving raise to osmotic blistering
- Cathodic disbonding
- Cold wall effect

Prevented by

- Sufficient air arculation (especially in enclosed areas)
- Adequate removal of surface contaminants
- Proper level(s) of cathode protections of original coat(s)

Remedied by

- Blasting

Porosity

Voids (or vacuoles) in side the paint film

Caused by

- Solvent entrpment
- Salt (or oil / moisture)
- Conlam

Bleeding

Colour change in finish coats

Caused by

- Migration of

Remedied by

- Application of suitable sealer coat plus reapplication of finish (if esthetically unacceptable)

- Nothing (if estethically acceptable)

Bleeding does not affect anti-fouling property

Peeling (Flaking)

- (Dirt under dried paint film)

Caused by

- Contamination on substrate or underlying coat
- Stress in paint film exceeds adhesion force

Remedied by

- Blasting (possible removal of contaminant)

Chalking

(Gradual thinning of finish coat to expose underlying coat)

Caused by

- Degradation

Remedied by

- High pressure water jetting to remove underbond pigments and failler

Chedking

(Norrow breaks, usually short, in topcoat exposing underlying caot)

(non-directional) (Aligatoring)

Caused by

- Limited paint flexibility
- Too thick coat

- Applied at too high substrate temperation
- Underlying coat soft

Remedied by

Cracks (cracking in top coat)

(Deep cracks in area of over thickness and sagging)

(Deep cracks in paint exposing substrate)

(Impact damage reverse side of bulkhead)

Caused by

- Paint shrinkage
- Limited paint flexibility

Mud cracking of zinc silicate

Saponification

Alkyd paint on the zinc rich paint substrate

Reaction on interface alkyd zinc resulting in zinc soap formation

Blushing

Caused by

- Precipitation or moisture on fresh paint

  ---moisture mixed into liquid paint

  ---unbalanced thinner in spay application
- Amine flotation due to cold / damp conditions (amine sweating / blushing)

Remedied by

Pinpoint rusting (too low DFT at overlap of PFP)

(Corrosion at pinholes or holiday)

Caused by

- Pinholes in paint film
- Too high steel surface profile
- Too thin paint film
- Particle cntamination underfilm

Prevented by

- Contral of surface profile
- Control of DFT
- Use of holiday detector to localise pinholes

Remedied by

- Abrade and wash

Abrasive particales under the coating film

Fading

Caused by

- UV-rays

Under cutting

(Blistering and / or peeling of paint at breaks in film)

Day9

Health-safety-environment

Precautions must be taken to

---prtect worders' health

---prevent accidents

---pretect the environment

Health

- Individual countries and companies usually have lows, rules and regulations governing vorkers' health.
- Such laws, rules and reglatious apply to inspectors as well
- Be a good example
- Ventilation

  ---general ventilation

  ---point exhoustion

- Dust

  ---irritating to eyes, muaous membranes, lungs

  ---poisonous particles

  ---silicosis

- Solvents

  ---explosion hazard (lower and upper explosion limits

  ---intoxicating and destructive

  --Brain and norves

--Eyes

--Respiratory system

--Skin

--Arculatory system, kidneys and liver

--Reproductive organs

- Absorbed through respiratory system and skin
- Acute effects

---intoxication dizziness, solvenness, daring and finally loss of consciousness

---Running eyes

- Chronic effects

---loss of concentration, co-ordination and memory

---irritability and aggressiveness

---liver and likney damages

Threshold limit value ---TLV

TLV is defined as the concentration of any substation which will not cause harm to individuals when breathing this contamination …

Allergy and excema

Caused by

- Solvents (washing)
- Paint components (epoxy / polyurethane)
- Cleaning agents (alkalis)

- Dust (containing biocides or heavy metal)

Concerogenic substances

- PAH (polyaromatic hydrocorbons) – in tars
- Chromates- mostly token out of formulations
- Amines, amides and adducts – in curing agents
- Benzene – mostly taken out of formulation, but still in gasoline

Protective equipment

- Glosses / goggles, gloves, coverall, safety boots
- Protective cream
- Filter mask / fresh air mask
- Personal hygiene

No smoking in areas with solvent concentrations- explosion / phosgene gas.

Safty

Scaffolding

- Erected according to regulations
- Well fastened – not free standing

Lighting

- General good ligting
- Spot tights

Personal safety

- Helmet and safety boots

- Eye protection
- Form fitting work clothes
- “Buddy system” in dangerous places
- Chech that it is safe where you are going

First aid

- Solvent or paint in eyes

  Flush with fresh water forminimum (5 min. and bring person to hospital)

- Paint on skin

  Wash thoroughly with soapand water pr special cleaning compound (see docter after words)

Open wounds (P5)

- Stop bleeding (if possible) and bring person to hospital immediately

Solvent or paint swallowed

- Bring person to hospital immediately

Do not try to induce vomitiny!

Paint through body part (from airless spray gun)

- Bring person to hospital immediately

Flash point: is the lowest temperature at which a liquid liberates sufficient vapour to form a mixture with the air near its surface which, if ignited, will make a small flash , but not catch fire

Ferms and definition

Explosive atmosphere is a mixture of solvent fumes and air at a concentration which is above the lower and below the upper explosion limits.

Ignition temprature is that temperature to which a substance must to heated to ignite without any offer cource of ignitions

(e.g. apark, flame)

Ignition source is an external source of ignition with sufficient temperature to ignite a substance (e.g. spark, flame, hot surface)

Fire fighting is all actions directed at extinguishing fires.

Environment

- Dust containment
- Solvent containment
- Noise containment
- Wast disposal