STYRENE PARK OFFSITE

Document Title:

Painting Procedure

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REVISION RECORD SHEET

Page Page	Revisions								Page	Revisions						
	R0	R1	R2	R3	R4	R5	R6			R0	R1	R2	R3	R4	R5	R6
1	X	X							41		X					
2	X	X							42		X					
3	X	X							43		X					
4	X	X							44		X					
5	X	X							45		X					
6	X	X							46		X					
7	X	X							47		X					
8	X	X							48		X					
9	X	X							49		X					
10	X	X							50		X					
11	X	X							51		X					
12		X							52		X					
13		X							53		X					
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Painting Procedure for Compressor Skid

1. Purpose

This work-instruction is applicable whenever epoxy primer and final standard coating is required on bare compressor and compressor packages. It regards carbon steel and cast iron frame, piping and equipment surfaces only. See below for further detail.

2. Definitions

Not applicable

3. Performers

All thereto appoint operators, which had the related 'on the job training'.

4. Instructions and criteria's

4.1. Surface preparation:

All equipment which needs to be painted will be cleaned as follows:

Thoroughly degreasing of all surfaces by use of Benzine D and air pressurized pistol.
Removing all discontinuities (e.g. weld spatters) by chipping and by grit blasting.
Grit blasting according SA 2 ½" where applicable.
Drying all surfaces by blowing air with an air pressurized pistol.
All surfaces will be clean and free from any contamination before the painting action will be proceeded.
Protect all openings, flange facings, identification plates, stem threads etc... by use of proper protection material.

4.2. Painting:

Check thoroughly for cleanliness of all surfaces and protection of all area's which need not to be painted, before proceeding.

Painting shall be done after hydro-test.

The paint will be applied by means of a manual spray pistol with an opening between 1.2 - 1.5 mm.
The spray pressure will be between 3 - 5 barA.

The paint action will be performed with a smooth horizontal or vertical movement of the spray pistol.
The distance between spray pistol and equipment will be ± 40 cm.
Painting shall be done indoors. The air temperature will be 5 – 40deg.C.
The relative humidity will be 50 – 80%.
All steel temperatures will be at least 3deg.C above dew point of the surrounding air.

Items not to be painted:

1) Stainless steel surfaces
2) Aluminium surfaces (except caps)
3) Name- and tag plates
4) Levers
5) Galvanized surfaces
6) Visual wiring
7) Coupling covers
8) Insulation
9) Stem threads
10) Flange facings
11) SS Valve body, stem, handle, Actuators

Items painted to Manufacturer Standard:

1) Electric Motors
2) Instruments
3) Heaters
4) PLC panel, junction boxes
5) Compressor and oil pump

Following coats will be applied on all other surfaces:

1st Coat : Hempadur Fast Dry 15560 Or Equivalent
2 component zink fosfate HB primer
Layer thickness: min. 75 µm DFT

2nd Coat: Hempadur 15570 Or Equivalent
2 component epoxy primer,
Layer thickness: min. 75 µm DFT

Final Coat : Hempathane HS 55610 Or Equivalent
Top coat is a high build 2 component acrylic polyurethane finish.
Layer thickness: min. 75 µm DFT

Dilution: as specified in the final coating technical documentation
Remover: BENZINE D or other appropriate remover
Drying time: as specified in the final coating technical documentation
Hardness: as specified in the final coating technical documentation

Final dry film thickness will be min. 225 µm

4.3. Colors:

Process and utility piping Pressure vessels, heat exchanger	RAL 7038
Compressors, Pumps	RAL 7038
Motors	RAL5015
Safety valves	RAL 7038
Base frame and external steel work	RAL 7038
Ladders, stages & supports	RAL 7038
Local panel, Junction boxes	Mfr. Standard

5. Registration

After cleaning following requirements shall be met:
- All surfaces will be visually clean and free from any contamination.

Before painting:
- Ambient conditions (impression).
- Steel condition (impression).

After painting following requirements shall be met:
- Uniform consistency of paint
- No paint gutters allowed
- No blank material visible
- No foreign materials in paint

After painting a visual inspection according the above requirements and a thickness measurement will be performed.
All results will be recorded on an inspection report and filed within the relevant job order file.

All above mentioned coats (DFT) will be measured by the use of the coating thickness gauge ELCOMETER 345 or other appropriate equipment. Perform a measurement at 20 different spots of the equipment.
All readings must be within the tolerances.

Inspection report: thickness of all layers must be within the tolerances. Registration in report MF/10/Q009

6. Appendix

Selected coating technical documentation – Hempadur Fast Dry 15560, Hempadur 15570, Hempathane HS 55610 or Equivalent which is subjected to client confirmation.

Product Data

HEMPADUR FAST DRY 15560

15560: BASE 15569 : CURING AGENT 97560

Description: HEMPADUR FAST DRY 15560 is a two-component epoxy paint with a very short drying time. Contains zinc phosphate.

Recommended use: As a quick drying primer or intermediate coat in HEMPADUR systems for especially fast recoatable in-shop applications.
Can be used for on-site work too if eg VOC compliance is requested.

Service temperature: Maximum, dry exposure only: 140°C/284°F

Certificates/Approvals: Complies with EU Directive 2004/42/EC: subcategory j.

Availability: Part of Group Assortment. Local availability subject to confirmation.

PHYSICAL CONSTANTS:

Shade nos/Colours:	12170* / Grey. see REMARKS overleaf.
Finish:	Flat
Volume solids, %:	62 ± 1
Theoretical spreading rate:	6.2 m^2/l [248.6 sq.ft./US gallon] - 100 micron/4 mils
Flash point:	27 °C [80.6 °F]
Specific gravity:	1.4 kg/litre [12 lbs/US gallon]
Surface dry:	0.5 approx. hour(s) 20°C/68°F
Dry to touch:	1 - 1.5 hour(s) 20°C/68°F
Fully cured:	7 day(s) 20°C/68°F
VOC content:	351 g/l [2.9 lbs/US gallon]

**other shades according to assortment list.*

The physical constants stated are nominal data according to the HEMPEL Group's approved formulas.

APPLICATION DETAILS:

Version; mixed product:	**15560**
Mixing ratio:	BASE 15569 : CURING AGENT 97560 4 : 1 By volume
Application method:	Airless spray / Air spray / Brush
Thinner (max.vol.):	08450 (5%) / 08450 (15%) / 08450 (5%)
Pot life:	2 hour(s) 20°C/68°F
Nozzle orifice:	0.019 - 0.021 "
Nozzle pressure:	175 bar [2537.5 psi] (Airless spray data are indicative and subject to adjustment)
Cleaning of tools:	HEMPEL'S TOOL CLEANER 99610
Indicated film thickness, dry:	100 micron [4 mils] see REMARKS overleaf.
Indicated film thickness, wet:	175 micron [7 mils]
Recoat interval, min:	According to specification.
Recoat interval, max:	According to specification.

Safety: Handle with care. Before and during use, observe all safety labels on packaging and paint containers, consult HEMPEL Safety Data Sheets and follow all local or national safety regulations.

Product Data
HEMPADUR 15570

15570: BASE 15579: CURING AGENT 95570

Description:
HEMPADUR 15570 is a two component, polyamide-adduct cured epoxy paint, which cures to a strong and highly corrosion resistant coating, at temperatures down to -10°C/14°F. The Micaceous Iron Oxide pigmented reddish grey 12430 shade is also well suited for application under humid conditions, on damp steel surfaces, and may be applied on moist surfaces. The greyish yellow 21780 and the grey 11320 shades contains zinc phosphate.

Recommended use:
As a maintenance and repair primer, intermediate, and/or finishing coat in HEMPADUR systems in severely corrosive environment. As a finishing coat where a cosmetic appearance is of less importance. As a low temperature curing epoxy primer, intermediate, and/or finishing coat in paint systems according to specification. Well suited as a (blast) primer in epoxy systems.
Mist coat on GALVOSIL.

Service temperature:
Maximum, dry exposure only: 140°C/284°F
Ballast water service. Resists normal ambient temperatures at sea (Avoid long-term exposure to negative temperature gradients).
Other liquids: Contact HEMPEL

Certificates/Approvals:
Complies with European Fire Standard EN 13501-1; classification B-s1, d0.
Approved as a low flame spread material when used as part of a predefined paint system. Please refer to “Declaration of Conformity” on www.Hempel.com for further details.
Complies with EU Directive 2004/42/EC:subcategory j. (see REMARKS overleaf)

Availability:
Part of Group Assortment. Local availability subject to confirmation.

PHYSICAL CONSTANTS:

Shade nos/Colours:	12430 (MIO)* / Reddish grey
Finish:	Flat
Volume solids, %:	54 ± 1
Theoretical spreading rate:	5.4 m^2/l [216.5 sq.ft./US gallon] - 100 micron/4 mils
Flash point:	25 °C [77 °F]
Specific gravity:	1.4 kg/litre [11.6 lbs/US gallon]
Surface-dry:	1 hour(s) 20°C/68°F
Through-dry:	5 hour(s) 20°C/68°F
Fully cured:	7 day(s) 20°C/68°F
VOC content:	414 g/l [3.4 lbs/US gallon]
Shelf life:	3 years for BASE and 3 years (25°C/77°F) for CURING AGENT from time of production.

**other shades according to assortment list.*

The physical constants stated are nominal data according to the HEMPEL Group's approved formulas.

APPLICATION DETAILS:

Version, mixed product:	**15570**
Mixing ratio:	BASE 15579: CURING AGENT 95570 3 : 1 by volume
Application method:	Airless spray / Air spray / Brush
Thinner (max.vol.):	08450 (5%) / 08450 (15%) / 08450 (5%)
Pot life:	2 hour(s) 20°C/68°F
Nozzle orifice:	0.019 - 0.021 "
Nozzle pressure:	175 bar [2537.5 psi] (Airless spray data are indicative and subject to adjustment)
Cleaning of tools:	HEMPEL'S TOOL CLEANER 99610
Indicated film thickness, dry:	100 micron [4 mils] see REMARKS overleaf
Indicated film thickness, wet:	200 micron [8 mils]
Overcoat interval, min:	see REMARKS overleaf
Overcoat interval, max:	see REMARKS overleaf

Safety:
Handle with care. Before and during use, observe all safety labels on packaging and paint containers, consult HEMPEL Safety Data Sheets and follow all local or national safety regulations.

Product Data
HEMPADUR 15570

SURFACE PREPARATION:

New steel: Abrasive blasting to Sa 2½ (ISO 8501-1:2007). For temporary protection, if required, use a suitable shopprimer. All damage of shopprimer and contamination from storage and fabrication should be thoroughly cleaned prior to final painting. For repair and touch-up use: HEMPADUR
Other metals and light alloys: Thorough degreasing and (light) abrasive sweeping to remove contamination and to secure adhesion - surface profile depending on later exposure.
Stainless steel: (eg. ballast tanks of chemical carriers) to be abrasive blast cleaned to a uniform, sharp, dense profile (Rugotest No. 3, BN9a, ISO Comparator Medium (G), Keane-Tator Comparator 2. 0 G/S) corresponding to Rz minimum 50 micron. Any salts, grease, oil, etc. to be removed before abrasive blasting is commenced.
Maintenance: Remove oil and grease etc. thoroughly with suitable detergent. Remove salts and other contaminants by high pressure fresh water cleaning. Clean damaged areas thoroughly by power tool cleaning to St 3 (ISO 8501-1:2007) (minor areas) or by abrasive blasting to min. Sa 2, preferably to Sa 2½ (ISO 8501-1:2007). Improved surface preparation will improve the performance of the product.
As an alternative to dry cleaning, water jetting to sound, well adhering coat and/or to steel. Intact coat must appear with roughened surface after the water jetting. By water jetting to steel, cleanliness shall be: Wa 2 -Wa 2½ (atmospheric exposure) / minimum Wa 2½ (immersion) (ISO 8501-4:2006).
Acceptable flash-rust degree before application: maximum M (atmospheric exposure) / M, preferably L (immersion) (ISO 8501-4:2006). Feather edges to sound and intact areas. Dust off residues. Touch up bare spots to full film thickness. This should be done when the painted surface has reached the condition of being damp, possibly moist. In case of wet abrasive blasting a suitable inhibitor may be used. Surplus inhibitor and residual abrasives and sludge must be removed by (high pressure) fresh water cleaning before recoating. Cleaning with hot water is recommended.
Note 1: Inhibitors are generally not recommended for surfaces which will be immersed during service.
Note 2: Damp surfaces: water is not readily detectable, but the temperature of the surface is below the dew point. **Moist surfaces:** pools of water and droplets have been removed, but there is a noticeable film of water. **Wet surface:** droplets or pools of water are present.

APPLICATION CONDITIONS:

Use only where application and curing can proceed at temperatures above: -10°C/14°F.
At the freezing point and below be aware of the risk of ice on the surface, which will hinder adhesion.
The temperature of paint itself should be 15°C/59°F or above.
In confined spaces provide adequate ventilation during application and drying.
Occurrence of standing water or droplets on the painted surface immediately after application may result in discolouration.

PRECEDING COAT:

None, or as per specification.

SUBSEQUENT COAT:

None, or as per specification. Recommended systems are: HEMPADUR, HEMPATHANE, HEMPATEX

REMARKS:

VOC - EU Directive 2004/42/EC:

Product	As supplied	15 vol. % thinning	Limit phase II, 2010
1557012430	414 g/l	480 g/l	500 g/l

For VOC of other shades, please refer to Safety Data Sheet.

Weathering/service temperatures:

The natural tendency of epoxy coatings to chalk in outdoor exposure and to become more sensitive to mechanical damage and chemical exposure at elevated temperatures is also reflected in this product.

Film thicknesses/thinning:

May be specified in another film thickness than indicated depending on purpose and area of use. This will alter spreading rate and may influence drying time and overcoating interval. Normal range dry is: 50-125 micron/2-5 mils

Overcoating:

Overcoating intervals related to later conditions of exposure: If the maximum overcoating interval is exceeded, roughening of the surface is necessary to ensure intercoat adhesion.
Before overcoating after exposure in contaminated environment, clean the surface thoroughly with high pressure fresh water hosing and allow drying.

A specification supersedes any guideline overcoat intervals indicated in the table.

Environment	Atmospheric, medium					
Surface temperature:	-10°C (14°F)		0°C (32°F)		20°C (68°F)	
	Min	Max	Min	Max	Min	Max
HEMPADUR	36 h	Ext.	18 h	Ext.	4 h	Ext.
HEMPATEX	18 h	3 d	9 h	36 h	2 h	8 h
HEMPATHANE	36 h	90 d	18 h	45 d	4 h	10 d
Environment	Immersion					
HEMPADUR	3 d	Ext.	1½ d	Ext.	8 h	Ext.

NR = Not Recommended, Ext. = Extended, m = minute(s), h = hour(s), d = day(s)

Note:

HEMPADUR 15570 For professional use only.

Product Data
HEMPADUR 15570

Product Data
HEMPATHANE HS 55610

55610: BASE 55619: CURING AGENT 97050

Description: HEMPATHANE HS 55610 is a two-component glossy acrylic polyurethane topcoat, cured with aliphatic isocyanate, with good gloss and colour retention. Contains zinc phosphate.

Recommended use: As a VOC-compliant, high-build finishing coat for protection of structural steel in severely corrosive environment. May be specified as a one coat "Direct To Metal" system in environments classified as C2 and C3.

Service temperature: Maximum, dry exposure only: 120°C/248°F see REMARKS overleaf

Certificates/Approvals:

Approved as a low flame spread material when used as part of a predefined paint system. Please refer to “Declaration of Conformity” on www.Hempel.com for further details.
Complies with EU Directive 2004/42/EC: subcategory j.

Availability: Part of Group Assortment. Local availability subject to confirmation.

PHYSICAL CONSTANTS:

Shade nos/Colours:	10000/ White. (see REMARKS overleaf)
Finish:	Glossy
Volume solids, %:	67 ± 1
Theoretical spreading rate:	6.7 m^2/l [268.7 sq.ft./US gallon] - 100 micron/4 mils
Flash point:	31 °C [87.8 °F]
Specific gravity:	1.4 kg/litre [12 lbs/US gallon]
Surface-dry:	3 hour(s) 20°C/68°F
Through-dry:	8 hour(s) 20°C/68°F
Fully cured:	7 day(s) 20°C/68°F
VOC content:	336 g/l [2.8 lbs/US gallon]
Shelf life:	3 years for BASE and 2 years (25°C/77°F) for CURING AGENT from time of production.

**Wide range of colours available via Hempel's MULTI-TINT system.*
**other shades according to assortment list.*
The physical constants stated are nominal data according to the HEMPEL Group's approved formulas.

APPLICATION DETAILS:

Version, mixed product:	**55610**
Mixing ratio:	BASE 55619: CURING AGENT 97050 7:1 by volume
Application method:	Airless spray (see REMARKS overleaf) / Brush (see REMARKS overleaf)
Thinner (max.vol.):	08080 (5%) / 08080 (5%)
Pot life:	2 hour(s) 20°C/68°F
Nozzle orifice:	0.017 - 0.021 "
Nozzle pressure:	175 bar [2537.5 psi] (Airless spray data are indicative and subject to adjustment)
Cleaning of tools:	HEMPEL'S THINNER 08080
Indicated film thickness, dry:	100 micron [4 mils] / 4 mils (see REMARKS overleaf)
Indicated film thickness, wet:	150 micron [6 mils] / 6 mils
Overcoat interval, min:	see REMARKS overleaf
Overcoat interval, max:	see REMARKS overleaf

Safety: Handle with care. Before and during use, observe all safety labels on packaging and paint containers, consult HEMPEL Safety Data Sheets and follow all local or national safety regulations.

Product Data
HEMPATHANE HS 55610

SURFACE PREPARATION: According to specification.

APPLICATION CONDITIONS: Apply only on a dry and clean surface with a temperature above the dew point to avoid condensation.
Minimum temperature for curing is: -10°C/14°F
At the freezing point and below be aware of the risk of ice on the surface, which will hinder adhesion.
The film formation may be adversely affected by light rain, high humidity and/or condensation during application and the following interval after application:24 hours , 20°C/68°F
In confined spaces provide adequate ventilation during application and drying.

PRECEDING COAT: According to specification. Recommended systems are: HEMPADUR FAST DRY 15560, HEMPADUR MASTIC 45880/45881

SUBSEQUENT COAT: None.

REMARKS:

VOC - EU Directive 2004/42/EC:

Product	As supplied	5 vol. % thinning	Limit phase II, 2010
5561010000	336 g/l	362 g/l	500 g/l

For VOC of other shades, please refer to Safety Data Sheet.

Colours/Colour stability: Colour stability for some shades may be effected by exposure to harsh chemical atmospheres. This does not affect the performance of the coating. For certain colours (yellow, red, orange, green, etc.), extra coats may be necessary to obtain full opacity.
For aluminium pigmented shades scratching actions or high humidity/water may cause discolouration/ disturbances of the surface. This will have no influence on the performance. This phenomenon may be avoided by applying a clear varnish.

Weathering/service temperatures: At service temperature above 100°C/212°F, slight discolouration may be expected. The product will become softer.

Application(s): When specified as a one coat “Direct to Metal”-system follow “Good Painting Practise” and apply stripe coating before the spray application on areas difficult to cover properly by spray application.
CURING AGENT 97050 : is sensitive to moisture.
Even small traces of water in the mixed paint will reduce the pot life and result in film defects.

Film thicknesses/thinning: May be specified in another film thickness than indicated depending on purpose and area of use. This will alter spreading rate and may influence drying time and overcoating interval. Normal range dry is: minimum 50 micron/2 mils (diluted), minimum 75 micron/3 mils (undiluted), maximum 125 micron/5 mils

Storage Conditions: Store in a dry place and keep the can tightly closed until use.

Shades: This product is available in several aluminium pigmented shades with different volume solids content. Contact HEMPEL for more information.

Curing agent: Open curing agent cans with caution as overpressure might exist.

Overcoating: Overcoating intervals related to later conditions of exposure: If the maximum overcoating interval is exceeded, roughening of the surface is necessary to ensure intercoat adhesion.
Before overcoating after exposure in contaminated environment, clean the surface thoroughly with high pressure fresh water hosing and allow drying.

A specification supersedes any guideline overcoat intervals indicated in the table.

Environment	Atmospheric, medium					
Surface temperature:	-10°C (14°F)		0°C (32°F)		20°C (68°F)	
	Min	Max	Min	Max	Min	Max
HEMPATHANE	30 h	None	18 h	None	6 h	None

NR = Not Recommended, Ext. = Extended, m = minute(s), h = hour(s), d = day(s)

Overcoating note: A completely clean surface is mandatory to ensure intercoat adhesion, especially at long overcoating intervals. Any dirt, oil, grease, and other foreign matter must be removed with suitable detergent followed by (high pressure) fresh water cleaning. Salts to be removed by fresh water hosing.
To check whether the quality of the surface cleaning is adequate, a test patch may be relevant.

Note: **HEMPATHANE HS 55610 For professional use only.**

ISSUED BY: HEMPEL A/S 5561010000

Painting Procedure for Chiller Skid

Contents

1. Scope

The following procedures cover the minimum requirements for surface preparation and paint application of Heat Exchangers and Pressure Vessel that fabricated in Farnikan Co. for **PERSIAN GULF MEHR PETROLEUM Co**.

2. Reference Code and Standards

Painting Specification: Project Spec

3. Project Definitions

Project: CONCEPTUAL, BASIC and DETAIL DESIGN ENGINEERING OF STYRENE PARK OFFSITE.

Owner (Purchaser): TOASE-EHE PARK SANATI GOHAR OFOGJ PETROCHEMICAL CO.

Consultant: HAMIAN SANAT ENERGY.

Vendor: FARNIKAN CO.

Inspector: Person assigned by the Purchaser or Owner to inspect the specified services, equipment or system being provided by the Vendor.

4. Paint Suppliers Obligations

4.1. The vendor shall request paint supplier (the supplier shall be selected according approved sub-order list) to send technical data sheet and test and analysis certificates and submitted to vendor inspector for verification.

4.2. The paint supplier shall state shelf life of all paints and protective coating and shall provide recommendations for storage.

All product containers shall be marked with their batch number and initial supplier date. supplier shall provide a guarantee that no such materials have been reconstituted for any reason what so ever.

4.3. The latest available issue of paint data sheets for the particular batch shall be supplied by paint supplier.

4.4. The vendor shall be responsible for ensuring that he is in possession of the latest available issue of the paint data sheet and product safety data sheets printed by the paint supplier of the particular batch of paint to be applied. Such data shall include specific.

Recommendations and instructions concern. Shelf life, pot life, thinners, directions for thinning and mixing, drying time, curing time, recommended spray equipment, safety equipment, cleaning solvent and any other provisions for application of both primer and finish coats. Product safety data sheets shall include information concerning general

composition, physical data hazards and precautions during and after application, toxicity / first aid, storage, spillage and waste disposal. These recommendations shall be considered inherent part of this specification and followed accordingly.

The vendor shall, if requested, provide the latest original issue of the paint supplier's data sheets with their technical offers for approval.

5. Design Requirement

5.1. Coating for the protection shall be designed and applied for the application over the specified minimum surface preparation standards detailed in this procedure.

5.2. All coating shall be suitable for application and service in salty and corrosive environment conditions.

5.3. The paint system shall be based on the operation temperature of the equipment and reference specification.

6. General

6.1. The vendor shall provide and maintain in good condition all paint, equipment and tools necessary to carry out the work in an efficient manner.

6.2. The vendor shall provide, unless otherwise instructed, all paints and thinners necessary to carry out the work. The vendor shall purchase such paints from approved suppliers. Vendor shall provide touch up painting material to repair damaged areas during shipment and installation.

6.3. The vendor shall provide skilled and experienced personnel to carry out the work together with competent and qualified supervision.

6.4. The vendor shall comply fully with this specification unless otherwise approved by the Purchaser. Additionally, the work will be subject to continuous inspection by the inspector who will be at liberty to check at every stage that the work is being carried out in accordance with all aspects of this specification

6.5. The following surface and material shall require painting:

Insulated stainless steel surfaces within temperature range 450°C-800°C.

6.6. The following surfaces and materials shall not require painting:

- Stainless steel surfaces

- Uninsulated SS surfaces

- Insulated SS surfaces at temperature below 450°C

- Non-metallic surfaces except when required (solar protection)

- Nonferrous surfaces (e.g. aluminum, brass, copper, etc.)

- The following parts of carbon steel and low-alloy steel surfaces:

- Surfaces which should obviously not be painted (e.g., nameplates, mechanically finished surfaces, etc.)

- Bolt /nuts for location to be frequently removed, such as manholes, inspection holes.

7. Surface Preparation

7.1. Paint life depends primarily on surface preparation. Surface preparation should remove foreign bodies to allow the type of priming paint used to wet the surface thoroughly and develop adequate adhesion.

7.2. Selection of abrasive for blast cleaning shall be in accordance with the recommendations given in specification and the recommendation agreed with the individual paint supplier for each type of paint used. In over case we will use approved grit for blast cleaning.

7.3. Selection of abrasive for blast cleaning shall be in accordance with the recommendations given in SSPC-SP-COM and the recommendations agreed with the individual paint vendor for each type of paint used Generally, this shall give a surface profile or anchor pattern within the range 30-50 microns with rough peaks to 100microns (Rz). Expendable grit (from copper slag only) 16-80 mesh; B.S. sieve series hall be used. Grits shall not be recycled.

7.4. Surface preparation shall not take place in the following Conditions:

a) At temperature below 5° C.

b) When the relative humidity is greater than 80%

c) When the metal surface temperature is less than 3˚C above the ambient dew point.

d) Outside daylight hours on exterior locations.

e) When it is raining or rain is imminent.

f) During foggy or misty conditions.

g) Surface preparation operations shall be terminated early enough during the day to permit application of the primer on the prepared surface before the sunsets. In case that paint supervisor allows applying surface preparation at night, the prepared surface shall be wiped the next morning. They shall be freshened with light sand blasting before the primer is applied.

7.5. Surface preparation on new steel surface shall remove all surface irregularities and mill-scale, together with all rust and surface contamination such as grease, dirt and solid pollution.

7.6. All abrasives shall be free of dust, dirt and other foreign matter. They shall be kept dry all time and shall not be recycled, unless permitted by client authorized inspector.

7.7. Coating may be applied by brush, roller, conventional spray or airless spray methods as approved or specified by the coating supplier. The compressed air supply used for blasting shall be free from water and oil. Adequate separators and traps shall be provided and these shall be kept emptied of water and oil.

Accumulations of water and oil shall be removed from the air receiver by regular purging. This clause shall also apply to air used for the dusting of cleaned surfaces. The pressure and the volume of compressed air supply for blast cleaning shall meet the work requirements. Nozzles shall be of the correct size and provide the most suitable spray shape for the most effective & economical application of the coating without excessive overspray.

7.8. Surface preparation shall result clean surface compatible to SA-2 ½ as per ISO-8501-1 and sspc. Vis-1-degree sp 10.

7.9. Chipping, scraping and steel wire brushing using manual or sand paper (if applicable) or power-driven tools

shall only be used where blast cleaning is impractical, with the approval of Purchaser authorized inspector.

7.10. During surface preparation, care shall be taken not be damaged or alter identification plates, machined surface

and parts coated in the factory, these parts shall be properly protected.

7.11. Any oil, grease, dust or foreign body present on the surface after surface preparation shall be removed before painting. If rust reappears on the surface, the surface shall be reblasted.

7.12. During the surface preparation we should protect name plate and machined from sandblasting.

8. Storage, Mixing and Thinning of Products

8.1. Storage Condition

8.1.1. All paints and thinner containers shall be kept closed before use and stored under shelter.

8.1.2. Any paint, which has gelled or settled during storage, shall not be used.

8.1.3. Any paint for which the shelf life is expired shall not be used.

8.2. Mixing

8.2.1. All the ingredients in each container shall be thoroughly mixed and homogenized. Mechanical mixing shall be such that all pigments or other agents are held in solution during application. Manual mixers are not authorized for quantities greater than 5 liters.

8.2.2. Paint mixed in the original container shall not be transferred until all settled particles have been remixed with the medium to facilitate mixing.

8.2.3. Paint shall not mix or held in solution with air bubbles.

8.2.4. If a skin has formed in the container and skin is thicker than 1mm, the paint shall notbe used.

8.2.5. All the pigmented products shall be strained after mixing unless applicator equipment is provided with adequate strainers. Strainers must allow all pigments to pass through, but not any skin.

8.3. Thinning

8.3.1. No thinners are to be added unless necessary for proper application, thinning must never exceed supplier recommendations.

8.3.2. Thinners used must be those suggested by the supplier.

8.3.3. When use of thinner is authorized by the supplier, it shall be added during mixing. Applicators shall not be adding consistency. Thinners must be added under the guidance of the specialist who is thoroughly familiar with the quantity and type of added thinner.

8.3.4. Adding a small percentage of thinner will give no measurable difference in the film thickness. There are cases, however, when a higher degree of thinning is necessary and justified. It should then be kept in mind that adding thinner increases the quantity of liquid paint without contributing to the solids content. Consequently, a proportionally higher wet film thickness must be applied when adding any significant amount of thinner in order to obtain the specified dry film thickness.

VS% after thinning = (VS%*100) / (%thinner added + 100) above calculation is necessary to determination of wet film thickness that be used for obtaining of required dry film thickness.

9. Priming

9.1. Prepared surface should be primed generally within four hours or before visible re-rusting occurs. Cleaned surface shall never be left overnight prior to coating; in such case re-blasting or re-cleaning is necessary.

9.2. In order to minimize contamination between successive coat of paint, over coating of the preceding coat shall be done as soon as it is permitted by the particular specification, and not delayed beyond the period specified. When delays are unavoidable, the painted surface shall be thoroughly cleaned and dried to the satisfaction of company before over coating may take place.

9.3. Any primed surface which has been exposed for more than a few days will have become contaminated and should be cleaned down with fresh water and allowed to dry before over coating.

9.4. Although zinc rich primer is very effective in preventing rusting, extended exposure develops a surface contaminated of zinc corrosion products which rich impair the adhesion of subsequent coats. Zinc rich primers, both organic and inorganic which have been exposed long enough to develop white surface staining, should be prepared for over coating by one of the following methods.

-Light blast cleaning and dust removal.

-Wire brushing, followed by water washing.

-Scrubbing with fresh water, using bristle brushed.

9.5. The primer and finishing coat paint shall be from the same supplier for each system to ensure compatibility.

10. Painting

10.1. All painting shall be carried out in conformity with the specification and with the paint supplier's recommendation. Paint application shall also follow procedures covered SSPC-PA1"shop, field and maintenance painting.

10.2. Particular attention shall be paid to the supplier’s instructions on storage, mixing, thinning and pot life, the paint shall only be applied in the manner detailed by the supplier, e.g. brush. Roller, conventional or airless sprays and shall be applied under the supplier's recommended condition.

Minimum and maximum time intervals between coats shall be closely followed.

10.3. Hand mixing of paints shall only be permitted for containers up to 5 liters. All larger containers shall be mixed by mechanical agitators and brought to a uniform consistency. Where pigment separation readily occurs, provision shall be made for continuous mixing during application.

10.4. Two-pack paints shall be mixed in strict accordance with supplier's instruction. The pot life such paints shall be specifically noted and any mixed paint, which has exceeded its pot life, shall be discarded irrespective of its apparent condition.

10.5. Painting shall not take place under adverse weather conditions:

a) In particular rain, fog, snow or when such conditions are likely to occur before the paint has become dry.

b) At temperature below 5° C.

c) When the relative humidity is greater than 80%

d) When the metal surface temperature is less than 3˚ C above the ambient dew point or above the manufacturer's limit.

e) Outside daylight hours on exterior location.

10.6. The method of application shall be selected to ensure that the paint is applied in a uniform manner to the prescribed film thickness without any runs, sags or other blemishes. The pressure and volume of the compressed air used for spray application shall meet the work requirements and be free from oil and water contamination. Traps, separators and filters shall be emptied and cleaned regularly. Application of primers on wire brushed surface shall be by brush.

10.7. To ensure that the minimum thickness is achieved all angles, corner, bulkheads, weld, etc. such edges shall be stripe painted separately before applying the main system. Holding primers shall only have permitted where they are obtained from the same supplier source as the main priming coats and where the supplier is able to provide a full guarantee that satisfactory inter coat adhesion will occur.

10.8. Intervals between coats shall comply with supplier's recommendation and should generally, be kept to the absolute minimum in order to prevent contamination between coats. Where contamination occurs between coats,

this shall be completely removed, generally by washing with a suitable detergent solution and rinsing with clean freshwater.

10.9. All points of damage to paint work incurred at any stage of work, shall be re-prepared

by blast cleaning or wire brushing to original standard and recoating with the specified priming coat to restore the film thickness.

10.10. The primed surfaces having mechanical damages or rusting inclusive of weld seam,

shall be prepared and treated by a powerful wire brushing to the degree St3 per standard ISO 8501-1:1988. The touch-ups shall than is done, using two pack epoxy zinc-rich primer in two coats, d.f.t.30 microns for each coat.

10.11. All points of damage to paint work incurred at any stage of the work, including shop

welding operation, shall be re-prepared by blast cleaning to the original standard and recoating with the specified priming coat to restore the film thickness. In all such instances preparation shall extend 25 mm into the sound paintwork and a further25mm of sound paintwork shall be lightly blasted to etch the surface. Repainting shall then over the prepared surface and the etched paintwork. Where blast cleaning cannot be carried out, surface preparation of damage by scraping and power wire brushing is acceptable provided specific Purchaser gives approval. In such instance, modification of the originally specified primer may be necessary to suit the change method of surface protection.

Primer to finish layer paint material shall be supplied from same manufacturer. Subsequent coats shall be of a distinctly different shade. In case of using light colors for finish coat, the intermediate coat shall be selected with a proper color, in order to avoid any darkness in finish coat.

11. Inspection

11.1. Vendor shall advise the Purchaser Client / TPI inspector before commencing specific paint applications, and technical data sheet of paint supplier shall be available to inspector during paint application as well as this procedure.

11.2. Inspector shall have the right to inspect the paintwork at all stages and to reject any and all tools, instruments, material, staging or equipment of work which do not conform to the specification.

11.3. Each coat paint shall be free from defects and damage. Finished paint shall have the correct shade, degree of gloss and evens and be free from tack ness after drying/curing and free from cracks, holidays, runs, sags, wrinkles, patchiness brush or roller marks or any defects that may be deleterious to the quality of the coating.

11.4. Prior final acceptance of completed work, a joint inspection shall be made by vendor and Purchaser inspector and

an agreed inspection report to be signed by both parties.

11.5. Before commencement of shop preparation and painting, a meeting between the coating supplier, vendor and responsible inspector (as per approved ITP) shall be convened, to establish and agree, when necessary, visible blast standard, blast profile, satisfactory application the coating and agreement and calibration of inspection equipment.

11.6. Each coat shall be inspected prior to application of the next coat, Areas found to contain runs, over spray, roughness, cracks or other signs of improper application shall be repaired or recoated in accordance with the authorized inspector recommendation.

12. Quality Control and Testing

12.1. Vendor shall submit to company for approval, his proposed quality control and testing procedures covering all phases of surface preparation and paint application.

12.2. suppliers of all materials shall supply test certificates of all tests performed and certificate of compliance stating that the material meets the requirements of the applicable specification.

12.3. Before paint application the prepared surface shall be inspected visually (checked by roughness gauge if needed) by Quality control inspector and if the result is satisfactory the parts can be released for painting.

12.4. Following test to be done after paint application.

-Visual check

-Thickness check

-Adhesion test

12.5. Thickness Check

- Dry paint thickness shall be measured with a magnetic probe, such as micro test of Elcometer or equivalent. It is imperative that the magnetic probe be calibrated for each thickness of coating steel support with a non-magnetic block whose thickness is as close as possible to the coating being checked.

- For the determination of dry film thickness, 22 measurements shall be taken in the respective area. The lowest and highest value shall be disregarded.

NOTE: Average of spot measurements >= specified DFT

All individual measurements >= 80% of specified DFT.

- For each successive coat, the minimal allowable thickness shall be at least 100% of the specified thickness; the maximum thickness shall not exceed 120% of the specified thickness. If the paint remains soft or shows mud crack or orange skin or wrinkling, the paint shall be rejected and request for new application.

In order to achieve the specified dry film thickness, frequent checks of wet film thickness shall be carried out during the paint application with film thickness gauges such as the Elcometer wheel or comb type.

12.6. Adherence Check

a) For final coating paint adherence shall be checked as per ASTM method D3359.

Method A (x cut) shall be-used for paint film thicker than 125 microns; Method B (Lattice pattern) shall be used for paint film up to 125 microns.

Test Method A: An X-cut is made in the film to the substrate.

Pressure-sensitive tape is applied over the cut and then removed. Acceptable rating is 5A (No peeling or removal) or 4A (Trace peeling or removal along incisions or at their intersections.)

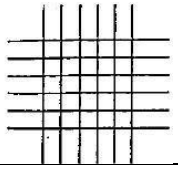
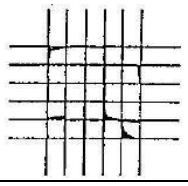
Test Method B: A lattice pattern with either six or eleven cuts in each direction (cross cut) is made in the film to the substrate; Pressure-sensitive tape is applied over the lattice and then descriptions and illustrations. Spacing between the cut lines shall be 1mm for film thickness up to 50 microns and 2 mm for film thickness from 50 to 125microns.

Acceptable results are rate 5B (the edges of the cuts are completely smooth, none of the squares of the lattice is detached) or 4B (small flakes of the coating are detached at intersections; less than 5% of the area is affected). According to below table:

-If the test is unsatisfactory, the entire surface shall be blast cleaned and repainted.

-Adhesion of the total paint system shall not be less than 1.5 Mpa (15 kg/cm2) measured by pull off test. (As defined in ASTM D4541.

Table 1

CLASSIFICATION OF ADHESION TEST RESULTS ACCORDING TO ASTM D3359-02		
CLASSIFICATION	PERCENT AREA REMOVED	SURFACE OF CROSS-CUT AREA FROM WHICH FAKING HAS OCCURRED FOR SIX PARALLEL CUTS AND ADHESION RANGE BY PERCENT
5B	0% None	
4B	Less than 5%	

12.7. Inspection Results

All quality control results shall be written up into reports.

All reports shall be submitted to Purchaser / client for approval

12.8. Humidity Check

The relative humidity of the air shall be measured with a Psychomotor (according to ASTM E337). Surface preparation and/or paint applications operations shall not commence until relative humidity is more than 85%. Relative humidity shall be measured and recorded a minimum of six times a day whence two times before commencement of work. Moisture on the surface being prepared or painted shall be measured every day with a surface moisture indicator before beginning surface preparation operations or applying a coat of paint.

12.9 Roughness Check

Total angular roughness of the surface shall be measured and recorded after surface preparation. A minimum of two measurements or impression shall be made per square meter of prepared surface.

All surfaces shall be blast cleaned to obtain a total angular roughness as below:

- Between 30 and 50 microns when total thickness of the coat of paint applied is less than 400 microns.

- Between 50 and 80 microns when total thickness of the coat of paint applied is greater than 400 microns.

Note: relevant test method is ASTM D 4417.

12.10 MEK Test

Test method for resistance of ethyl silicate (primer coating): in this method we use a solvent rub technique for assessing the MEK resistance of ethyl silicate zinc-rich primers the MEK resistance of some two-component ethyl silicate zinc-rich primers has been shown to correlate well with the cure of the primer as determined by diffuse reflectance infrared spectroscopy. the technique can be used in the fabricating shop.

13. Repair of Defects or Damage

13.1. Any defect of damage that may occur shall be repaired before the application of further coats and where necessary the particular surfaces made paint free. Remedial work shall be carried out prior to packing for shipment.

13.2. Areas where due to inadequately prepared surface solvent entrapment, excessive application of prime and/or finish coats, etc.

The tested paint system consistently fails to meet the required test standards for adhesion; the vendor shall remove the affected area by blast cleaning and shall reapply the full paint system to meet the required standard.

13.3. Area, which is to be over coated, shall be thoroughly cleaned free from grease, oil and other foreign matter and shall be dry. The surface shall then be prepared to the standard as originally specified (for large damaged areas), or prepared to the highest possible standard using mechanically operated tools (for small local damaged spots to 1 m2).

14. Paint System

- Paint system applicable shall be in accordance with tables 2,3

15. Attachments

Attachment 1.: Painting Inspection Report

Table 2. ITEMS DESCRIPTION

Item No.	Operating Temperature °C		Insulation		Painting System		RAL No.
	Shell Side	Tube Side	Shell Side	Tube Side	Shell Side	Tube Side	
CHILLER	1.24 / 1	15.2 / 5	YES	YES	P1	P1	7038

Table 3. PAINTING SYSTEM FOR EQUIPMENT AND LEG

Painting System No.	Surface Preparation	Insulation	Coating	Painting Code	Paint type	No. of Layers	DFT (µm)	Total DFT (µm)
Painting System 1	**SA 2 1/2**	**YES**	**Primer**	-	Zinc Rich Epoxy	**1**	**75**	**225**
			Intermediate	-	Epoxy polyamide MIO filled	**1**	**100**	
			Top Coat	-	Aliphatic Polyurethane	**1**	**50**	

Painting Procedure for Condenser (Air Cooler)

17. Coating thickness

18. Testing for adherence

19. after treatment

20. VISUAL INSPECTION

21. TOUCH-UP AND REPAIR

PAINTING

1.PURPOSE

This procedure is intended as an information aid to inspection painting.

2.SCOPE

This procedure included the key elements of surface preparation, coating application, qualification of painting shop, and measuring hardness that is applicable ***for header boxes and steel structure parts of air cooler*** that will be procured in **"Toase-ehe Park Sanati Gohar Ofogh Petrochemical Co. CONCEPTUAL, BASIC and DETAIL DESIGN ENGINEERING OF STYRENE PARK OFFSITE".**

As per related documents, just ladder & steel structure & Header shall be painted. The other parts: Fan ring, plenum, bundle frame, support mechanism & fan drive, grating & header walk way parts shall be hot dip galvanized.

3.REFERENCE

ISO 8501-1 Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness -

Part1 Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.

ISO 8501-2 Part 2: Preparation grades of previously coated steel substrates

after localized removal of previous coatings.

ASTM A123 Specification for zinc (Hot-Dip Galvanized) Coatings on Iron and Steel.

SSPC-SP10. Section 10.2

4. DEFINITION

4.1. V (Vendor): Damafin

4.2. S.S.P.C: The Society for Protective Coating

5. RESPONSIBILITY

This procedure is managed by the Quality Engineering Department of Damafin.

6. SURFACE BLASTING

For Header boxes:

SURFACE PREPRATION ACCEPTANCE DEGREE: STANDARD SIS, SA 2 1/2**.**

6.1. QUALITIES OF SURFACE FINISH

6.1.1. General

This procedure qualities of surface finish for all steels that are prepared by dry methods of blast-cleaning for the application of paints and nonmetallic coatings. It applies both to uncoated steel, whether new or weathered, and to steel from which an old protective coating has to be removed.

The quality of blast cleaned steel surface is defined is terms of cleanliness. There are no simple precise means of measuring these characteristics but the first can be estimated from the appearance of the surface and the second can generally be controlled within broad limits by the choice of blast cleaning procedure, and notably of the type and grade of abrasive.

6.1.2. Before Blasting

Many Materials, if nor removed from the surface, will affect the life of coating. These include oil, grease, soil, weld spatter, and slag that make it impossible to obtain proper adhesion to the metal surface.

Hand toll cleaning is the method used for the removal of loose mill scale, loose rust, loose or otherwise defective coating, weld flux, slag and spatter from metal surface by hand brushing, hand chipping or scarping using wire, fiber or bristle brushes, sandpaper, steel wool, hand scarpers or chisels, and chipping hammers.

6.2.2. Surface cleanliness

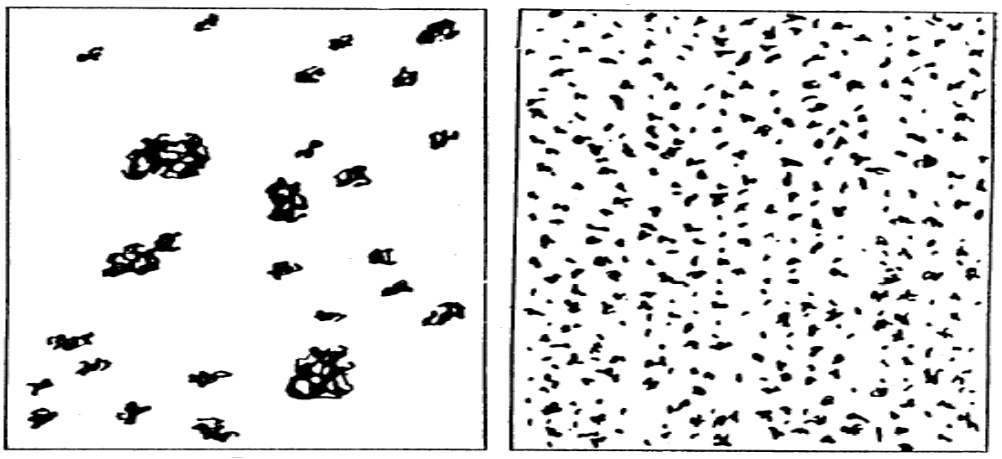
SECOND QUALITY (Near White) (SSPC-SP10), (SIS 05 59 00: SA 2 ½)

The entire surface shall show blast- cleaning pattern and shall be completely free from any contamination by oil, grease, dirt or other matter, except that tightly-bonded residues of mill scale or rust shall be permissible up to the following limits:

- For the whole surface: An average at least 95% of the surface shall be clean bare steel.

- For any single square of 25mm (1in) side, at least 90% of the square shall be clean bare steel.

WHOLE SURFACE (5% Mill scale residues)



Coarse **Fine**

MAXIMUM PERMITTED IN ANY SINGLE 25mm x 25mm (1in x 1in)

(10% Mill scale residues)

Coarse **Medium** **Fine**

Figure.6.1. Diagrammatic indications of second quality

Cleaning, the type and grade of abrasive and the blast cleaning procedure adopted.

Quality of surface finish	First quality	Second quality	Third quality
General appearance	Whole surface to show blast-cleaning pattern		
Description of finish : Clean bare steel	Whole surface	At least 95% of surface	At least 80% of surface
Extent of residue	Nil	Not more than 10% of any single square of 25mm(1in) side	Not more than 40% of any single square of 25mm(1in) side
Type of residue permitted: Mill scale Rust Paint or other coating Loose abrasive and dust	 Nil Nil Nil Nil	 Tightly-bonded residue Nil Nil	 Tightly-bonded residue Nil Nil

6.3. CONTROL AND INSPECTION

Methods of controlling the quality of surface finish, both with regard to cleanliness, are in course of development. For the time being, some measure of control can be exercised by comparison with agreed reference panels prepared beforehand to show the type of finish required. The following procedures have been found useful:

A sample piece at least 150 mm x 100 mm made from the metal identical to the base metal being treated and in the same surface condition, is held temporarily in position on the base. An area containing the sample piece is then blast-cleaned to the desired finish. The sample

piece is detached and placed in a clean, dry, airtight container, for later examination in the laboratory.

6.4. Blast-Cleaning Operation

6.4.1. Before Blast Cleaning

Many Materials, if nor removed from the surface, will affect the life of coating. These include oil, grease, soil, weld spatter, and slag that make it impossible to obtain proper adhesion to the metal surface.

Hand toll cleaning is the method used for the removal of loose mill scale, loose rust, loose or otherwise defective coating, weld flux, slag and spatter from metal surface by hand brushing, hand chipping or scarping using wire , fiber or bristle brushes, sandpaper, steel wool, hand scarpers or chisels, and chipping hammers.

6.4.2. The compressed air used for blast cleaning should be free of condensed water or oil by making certain that separators.

6.4.3. Because abrasive blast cleaning is hazardous operation, all work shall be conducted in compliance with applicable occupational and environmental health and safety rules and regulations.

6.4.4. As a preliminary to blast cleaning, all surfaces shall be solvent cleaned in accordance with SSPC-SP 1, sufficient to remove any visible deposits of oil, grease, drilling and cutting compounds. This method shall also be used as surface preparation, prior to painting galvanized surfaces.

6.4.5. All surfaces that require painting shall be near-white blast cleaned to pictorial standard Sa 2-1/2 of SS 05 59 00/ISO 8501-1/BS 7079: Part A1 read in conjunction with the descriptive standards of SSPC-SP10 and the relevant sections of SSPC-SP COM as listed in Section 10.2 of SSPC-SP10.

6.5. Blast Cleaning Abrasives

The selection of abrasive size and type shall be based on the type, grade, and surface condition of the steel to be cleaned, type of blast cleaning system employed, the finished

surface to be produced (cleanliness and roughness), and whether the abrasive will be recycled.

The cleanliness and size of recycled abrasive shall be maintained to ensure compliance with this procedure. The blast cleaning abrasive shall be dry and free of oil, grease, and other contaminations.

6.6. Weather Considerations

Blast cleaning operations shall not be conducted on surface that will be wet after blasting and before coating, when the surface are less than 3º above the dew point, when the relative humidity of the air is greater than 85%, or when the ambient temperature is below 5ºC, or outside daylight hours.

7. PAINTING

7.1. Specification

7.1.1. HEADERS: ALL CARBON STEEL HEADER BOXES

OPERATION TEMP. RANGE. : ⩽100 ºC

Surface Preparation: SA2 1/2

Primer: *Zinc Ethyl silicate* : 75 microns

Intermediate: 1- Tie coat, epoxy polyamide, 30 microns

2- Mid Coat, High Build Epoxy: 125 microns

Finish coat: *Acrylic* polyurethane: 75 microns

- TOTAL DRY FILM (DFT) 305 µ

- **RAL: 7038 (**Grey**)**

- **ADHESION DEGREE:** ACCORDING TO ASTM D **- 3359 / 4A**

7.2. Specification for Structural Steel works

Header walk way & support mechanism & Bolts/Nuts shall be hot dip galvanized according to ASTM A123.

STRUCTURE PARTS

OPERATION TEMP. RANGE.: ⩽100 ºC

Surface Preparation: SA2 1/2

Primer: *Zinc Ethyl silicate* : 75 microns

Intermediate: 1- Tie coat, epoxy polyamide, 30 microns

2- Mid Coat, High Build Epoxy: 125 microns

Finish coat: *Acrylic* polyurethane: 75 microns

- TOTAL DRY FILM (DFT) 305 µ

- **RAL: 7038 (**Grey**)**

- **ADHESION DEGREE:** ACCORDING TO ASTM D **- 3359 / 4A**

7.3. Curing And recoating time:

For the time and temperature required for curing, touch dry and over coating time

see paint manufacturer's instructions and data sheets

7.4. Cleaning and Preparation of Surfaces

7.4.1. Before application of any coating, all surfaces to be coated should be thoroughly cleaned and properly prepared to the requirements of the specification. All dust, dirt, oil, grease, moisture, soot.

7.4.2. Before painting; Surfaces that have been dry blasted should be brushed with clean brushes, blown with compressed air free of oil and moisture to eliminate any traces of blast products, dust, or dirt from the surface. This also serves to remove abrasive from pockets and corners.

7.4.3. Blast cleaned surfaces should be further treated, primed or painted on the same day they are blasted, preferably within 8h, or in any event before any visible flash rusting occurs. Re-blasting will be necessary on any surface if rust bloom forms before coating can be applied.

7.5. Qualification of Painting

7.5.1. Coating Storage and Handling

All coating and thinners should be stored in areas or structures that are well-ventilated and not subject to excessive heat, open flames, electrical discharge, or direct rays of the sun.

Materials susceptible to damage at low temperatures should be stored to prevent freezing, such as in heated areas. If a coating is stocked for a considerable length of time (several months), it is desirable to invert the containers at monthly intervals. This will prevent hard settling and thus make mixing quicker and easier when the coating is to be used.

Coating containers should remain unopened until needed, and the oldest should be used first.

Where a skin has formed in the container, the skin should be cut loose from the side of the container, removed, and discarded.

7.5.2. Mixing Coating

All coatings should be thoroughly and completely mixed in clean containers before use.

Some coatings may require straining after mixing, to ensure homogeneity and to remove skins and foreign matter. The strainers should be of a type to remove only skins, etc., but not to remove pigment.

Coatings should be agitated enough during application to ensure homogeneity. Some materials may even require constant agitation during use.

7.6. Qualification of painting shop

7.6.1. Weather Considerations

-Drying: Most coatings will not dry properly at low temperatures and high relative humidifies, nor will they perform well if applied over wet surfaces.

- Low temperature: The typical minimum temperature (air, material and surface) is usually 5ºC (40ºF), but may be as low as -18ºC (0ºF) for "cold- curing" one or two component system or 10ºC (50ºF) for conventional two component system.

- High temperature: The maximum reasonable surface temperature for application is 50ºC (125ºF). To keep the temperature down it may be desirable, where practical, to paint under cover at a shop or to protect the surface from the sun.

- Moisture: Painting should not be performed in rain, snow, fog or mist, or when the temperature of the surface is less than 3ºC (5ºF) above the dew point. This especially true in spring and fall when days are warm and night are cool. Wet surface should not be painted unless the coating is specifically designed for that condition. Relative humidity is usually an

indicator of condensing conditions and specifications often contain an 85% upper limit.

When coatings must be applied in damp or cold weather, the substrate should be painted under cover, or protected from the surrounding air, and the steel heated to a satisfactory temperature. The steel should remain under cover until the applied coating is dry or until weather conditions permit its exposure in the open.

7.6.2. Equipment's

The equipment should be suitable for the intended purpose.

The equipment should be kept in a suitably clean condition to permit proper coating application without depositing dirt, dried coating, and other foreign materials in the film.

The air supply for conventional and hot spray application should be free of moisture or oil.

Any solvents left in the equipment should be completely removed before applying coating to the surface being painted.

7.7. Measurement of Dry Film Thickness (D.F.T) With Electronic Gages

7.7.1. Instruments complying with this test method measure thicknesses by placing a probe on the coated surface and use electronic circuitry to convert a reference signal into coating thickness.

7.7.2. Verification of Calibration of Apparatus

Following the manufacturer's instructions, measure the thickness of a series of calibration standards covering the expected range of coating thickness.

7.7.3. Procedure:

- Use the instrument only after calibration has been verified in accordance with section 2.4.2.

- Ensure that the coating is dry prior to use of the instrument.

- Inspect the probe tip and surface to be measured to ensure that they are clean.

- Take readings in locations free of electrical or magnetic fields. The location should also be free of vibration.

- Make measurements at least 13mm (1/2 in) away from any edge or corner of the specimen. If necessary to measure closer than 13 mm (1/2 in), verify the effect (if any), the edge has on the measurement.

- Take a sufficient number of readings to characterize the surface.

- Certain characteristics of samples may affect the accuracy of the calibrations. These include:

-Surface profile of the substrate

- Surface profile of the coating

- Thickness of the substrate

- Geography of the sample surface (curves with small radius, small diameter, complex curve, etc.)

7.7.4. Report

Report the following information:

- Instrument used, serial number
- Range, and mean of the thickness readings

7.8. FILM DEFECTS

All coats should have nearly smooth surfaces relatively free of dry spray, overspray, orange peel, fish eyes, pinholes, craters, bubbles, or other significant defects.

Bleed-through, insufficient hiding, skips, and misses are not acceptable.

Runs and sags should be brushed out during application or removed by blasting if the coating has cured.

Abrasive, dirt, or other debris that becomes embedded in the paint film should be removed prior to the application of subsequent coats.

8. ADHERENCE TEST

8.1. Scope

8.1.1. These test methods cover procedures for assessing the adhesion of coating films to metallic substrates by applying and removing pressure- sensitive tape over cuts made in the film.

8.1.2. Test method A is primarily intended for use at job sites while Test Method B is more suitable for use in the laboratory. Also, Test Method B is not considered suitable for films thicker than 5 miles (125µm).

8.1.3. These test methods are used to establish whether the adhesion of a coating to a substrate is at a generally adequate level. They do not distinguish between higher levels of adhesion for which more sophisticated methods of measurement are required.

Note-1: It should be recognized that differences in adherability of the coating surface can affect the result obtained with coating having the same inherent adhesion.

8.1.4. In multicoat system adhesion failure may occur between coats so that the adhesion of the coating system to the substrate is not determined.

8.2. Summary of Test Method

8.2.1. Test Method A

An X-cut is made in the film to the substrate, pressure- sensitive tape is applied over the cut and then removed, and adhesion assessed qualitatively on the 0 to 5 scale.

8.2.2. Test Method B

A lattice pattern with either six or eleven cuts in each direction is made in the film to the substrate, pressure-sensitive tape is applied over the lattice and then removed, and adhesion is evaluated by comparison with descriptions and illustrations.

8.3. Significance and Use

8.3.1. If a coating is to fulfill its function of protecting or decorating a substrate, it must adhere to it for the expected service life. Because the substrate and its surface preparation (or lack of it) has a drastic, effect on the adhesion of coatings, a method of evaluation adhesion of a coating to different substrates or surface treatments, or of different coatings to the same substrate and treatment, is of considerable usefulness in the industry.

8.3.2. The limitations of all adhesion methods and the specific limitation of this test method to lower levels of adhesion (see 1.3) should be recognized before using it.

TEST METHOD A—X—CUT TAPE TEST

8.4. Apparatus and Materials

8.4.1. Cutting Tool— Sharp razor blade, scalpel, knife or other cutting devices. It is of particular importance that the cutting edges are in good condition.

8.4.2. Cutting Guide — Steel or other hard metal straightedge to ensure straight cuts.

8.4.3. Tape — One –inch(25mm) Wide semitransparent pressure – sensitive tape with an adhesion strength agreed upon by the supplier and the user is needed.

8.4.4. Rubber Eraser, on the end of a pencil.

8.4.5. Illumination— A light source is helpful in determining whether the cuts have been made through the film to the substrate.

8.5. Procedure

8.5.1. Select an area free of blemishes and minor surface imperfections. For tests in the field, ensure that the surface is clean and dry. Extremes in temperature or relative humidity may affect the adhesion of the tape or coating.

8.5.2. Make two cuts in the film each about 1.5 in (40mm) long that intersects near their middle with a smaller angle of between 30º and 45º. When making the incisions, use the straightedge and cut through the coating to the substrate in one steady motion.

8.5.3. Inspect the incisions for reflection of light from the metal substrate to establish that the coating film has been penetrated. If the substrate has not been reached make another X in a different location. Do not attempt to deepen a previous cut as this may affect adhesion along the incisions.

8.5.4. Remove two complete laps of the pressure-sensitive tape from the roll and discard. Remove an additional length at a steady (that is, not jerked) rate and cut a piece about 3in (75mm) long.

8.5.5. Place the center of the tape at the intersection of the cuts with the tape running in the same direction as the smaller angle. Smooth the tape into place by finger in the area of the incisions and then rub firmly with the eraser on the end of a pencil. The color under the transparent tape is a useful indication of when good contact has been made.

8.5.6. Within 90±30 s of application, remove the tape by seizing the free end and pulling it off rapidly (not jerked) back upon itself at as close to an angle of 180º as possible.

8.5.7. Inspect the X-cut area for removal of coating from the substrate or previous coating and rate the adhesion in accordance with the following scale

5A No peeling or removal,

4A Trace peeling or removal along incisions or at their intersection.

3A Jagged removal along incisions up to 1/16 in(1.6mm) on either side.

2A Jagged removal along most of incisions up to ⅛ in(3.2mm) on either side.

1A Removal from most of the area of the x under the tape

0A Removal beyond the area of the x

8.5.8. Repeat the test in two other locations on each test panel. For large structure make sufficient tests to ensure that the adhesion evaluation is representative of the whole surface.

8.5.9. After making several cuts examine the cutting edge and, if necessary, remove any flat spots or wire-edge by abrading lightly on a fine oil stone before using again. Discard cutting tools that develop nicks or other defects that tear the film.

8.6. Precision and Bias

8.6.1. Repeatability

Provided adhesion is uniform over a large surface, result obtained by the same operator should be considered suspect if they differ by more than 1 rating unit for two measurements.

8.6.2. Reproducibility

Two results, each the mean of triplicates, obtained by different operators should be considered suspect if they differ by more than 1.5 rating units.

8.6.3. Bias cannot be established for these test methods.

TEST METHOD B — CROSS — CUT TAPE TEST

8.7. Apparatus and Materials

8.7.1. Cutting Tool— Sharp razor blade, scalpel, knife or other cutting devices. Having a

cutting-edge angle between 15 and 30º that will make either a single cut or several cuts at once. It is of particular importance that the cutting edge or edges be in good condition.

8.7.2. Cutting Guide — If cuts are made manually (as opposed to a mechanical apparatus) a steel or other hard metal straight edge or template to ensure straight cuts.

8.7.3. Rule — Tempered steel rule graduated in 0.5 mm for measuring individual cuts.

8.7.4. Tape — as described in 3.5.3

8.7.5. Rubber Eraser, on the end of a pencil.

8.7.6. Illumination— as described in 5.5.

8.7.7. Magnifying Glass — an illuminated magnifier to be used while making individual cuts and examining the test area.

8.8. Procedure

8.8.1. Where required or when agreed upon, subject the specimens to a preliminary test before conducting the tape test.

After drying or testing the coating, conduct the tape test at room temperature.

8.8.2. Select an area free of blemishes and minor surface imperfections, place on a firm base, and under the illuminated magnifier, make parallel cuts as follows:

8.8.2.1. For coatings having a dry film thickness up to and including 2.0 mils (50µm) space the cuts 1mm apart and make eleven cuts unless otherwise agreed upon.

8.8.2.2. For coating having a dry film thickness between 2.0 mils (50µm) and 5.0 mils (125µm), space the cuts 2mm apart and make six cuts. For films thicker than 5.0 mils use Test Method A.

8.8.2.3. Make all cuts about ¾in (20mm) long. Cut through the film to the substrate in one steady motion using just sufficient pressure on the cutting tool to have the cutting edge

reach the substrate. When making successive single cuts with the aid of a guide, place the guide on the uncut area.

8.8.3. After making the required cuts brush the film lightly with a soft brush or tissue to remove any detached flakes or ribbons of coatings.

8.8.4. Make the additional number of cuts at 90º to and centered on the original cuts.

8.8.5. Brush the area as before and inspect the incisions for reflection of light from the substrate. If the metal has not been reached make another grid in a different location.

8.8.6. Remove two complete laps of tape and discard. Remove an additional length at a steady (that is, not jerked) rate and cut a piece about 3 in. (75mm)

8.8.7. Place the center of the tape cover the grid and in the area of the grid smooth into place by a finger. To ensure good contact with the film rub the tape firmly with the eraser on the end of a pencil. The color under the tape is a useful indication of when good contact has been made.

8.8.8. Within 90±30 s of application, remove the tape by seizing the free end and rapidly (not jerked) back upon itself at as close to an angle of 180º as possible.

8.8.9. Inspect the grid area for removal of coating from the substrate or from a previous coating using the illuminated magnifier. Rate the adhesion in accordance with the following scale illustrated in Fig.1.

5B The edges of the cuts are completely smooth; none of the squares of the lattice is detached

4B Small flakes of the coating are detached along edges and at intersection; less than 5% of the area is affected.

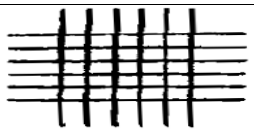
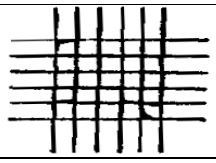
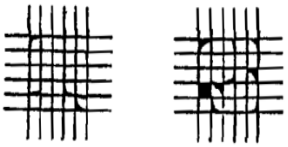
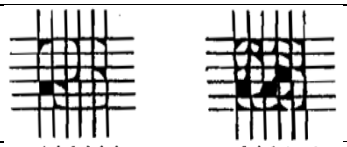
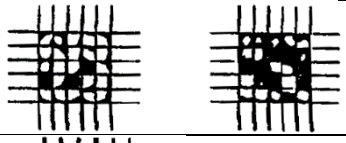
3B Small flakes of the coating are detached along edges and at intersections of cuts. The area affected is 5 to 15% of the lattice.

2B The coating has flaked along the edges and on parts of the squares. The area affected

is 15 to 35% of the lattice.

1B the coating has flaked along the edges of cuts in large ribbons and whole squares have detached. The area affected is 35 to 65% of the lattice.

CLASSIFICATION OF ADHESION TEST RESULT

Classificatio	PERCENT AREA REMOVED	**SURFACE OF CROSS CUT**
5 B	0 % NONE	
4 B	Less than 5 %	
3 B	5 – 15 %	
2 B	25 – 35 %	
1 B	35 – 65 %	
0 B	Greater than 65%	

8.8.10. Repeat the test in two other locations on each test panel.

8.9. Precision and Bias

8.9.1. Repeatability

Provided adhesion is uniform over a large surface, result obtained by the same operator should be considered suspect if they differ by more than 1 rating unit for two measurements.

8.9.2. Reproducibility

Two results, each the mean of triplicates, obtained by different operators should be considered suspect if they differ by more than two rating units.

8.9.3. Bias cannot be established for these test methods.

9. SAFETY EMPRISES:

Safety precaution are not addressed separately for each of the above operations.

Each has its own safety-related hazards, and U.S occupational Health and Safety Administration regulations should be followed. Materials Safety Data Sheet (MSDS) for the solvents and cleaning compounds provided by the manufacturer should also be consulted for proper worker protection.

M.S.D.S Products is flammable, keep away from heat and open flame, keep container closed use with adequate ventilation avoid prolonged and repeat contact with skin.

Irritating to eyes and skin may cause sensitization.

In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

Blasting equipment shall be of an approved design and manufacturer’s instructions shall be adhered to. In particular the following shall be adhered to:

- Remote operation by operator.
- Dead man's device on nozzle.
- External hose couplings. Internal connections are forbidden.
- Adequate safety clothing.

Operators shall wear air fed helmets at all times during blasting.

10. PAINT DATA SHEET

Paint data sheets are in attached pages.

GALVANIZING:

11. PURPOSE

This procedure covers the requirements for inspection the zinc coating (galvanizing) by the hot-dip process on iron and steel products made from rolled pressed and forged shapes, castings, plates, bars, and strips of Air-cooled heat exchangers that will be procured in "Toase-ehe Park Sanati Gohar Ofogh Petrochemical Co. CONCEPTUAL, BASIC and DETAIL DESIGN ENGINEERING OF STYRENE PARK OFFSITE".

12. SCOPE

This standard specifies the general properties of and methods of test for coatings applied by the hot dipping in zinc (containing not more than 2% of other metals) on fabricated iron and steel articles.

Fan ring, plenum, bundle frame, support mechanism & fan drive , grating & header walk way parts shall be HOT DIP GALVANIZED in accordance with ASTM-A123 or EN ISO 1461 and shall be inspected in accordance to this procedure.

Bolts, Nuts, Washer, PLUG AND PLUG GASKET shall be HOT DIP GALVANISED in accordance with ASTM-A153 or EN ISO 1461 or DECROMATE in accordance with ASTM-F1136.

13. REFERENCE

-ASTM A123: Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

- ASTM A 780: Standard practice for repair of damaged and uncoated areas of Hot – Dip Galvanized Coatings.

- ASTM A153

14. DEFINITION

14.1. Coating thickness

Total thickness of zinc that expressed in micrometer.

14.2. Signification surface

The part of the article covered or to be covered by the coating and for which the coating is essential for serviceability and/or appearance.

14.3. Control sample

The article or group of articles from a lot that is selected for sampling.

14.4. Reference area

The area within which a specific number of single measurements have to be made.

14.5. Local coating thickness

The mean value of coating thickness obtained from the specific number of measurements within a reference area for a magnetic test.

14.6. Mean coating thickness

The average value of the local thicknesses either on one large article or on all articles in the control sample.

14.7. Minimum value

Within a reference area, the lowest mean obtained from the specified number of measurements in a magnetic test.

14.8. Uncoated area

Areas on the iron or steel articles that do not react with the molten zinc.

14.9. Average coating thickness

The average of three specimen coating thicknesses.

14.10. Bath Composition

The molten metal in the working volume of the galvanizing bath shall contain no less than an average value of 98.0% zinc by weight.

15. Coating Properties

15.1. Surface condition

The surface of the basis metal should be clean before dipping into the molten zinc. Pickling in acid is the recommended method of cleaning the surface. Excessive pickling should be avoided.

Surface contamination that cannot be removed by pickling, e.g., carbon films (such as rolling oil residues), oil, grease, paint, welding slag and similar impurities should be removed prior to pickling.

Removing such impurities is in charge of the vendor.

15.2. The influence of steel surface roughness on the hot dip galvanized coating thickness

The surface roughness of the steel surface has an influence on the thickness and structure of the coating. The effect of surface unevenness of the basis metal generally remains visible after galvanizing.

A rough steel surface as obtained by grit basting, course grinding etc., prior to pickling, gives a thicker coating than a surface that is obtained by pickling alone.

Flame-cutting changes the steel composition and structure in the flame-cut zone, so that the coating thickness given in tables 2 are more difficult to obtain. In order to obtain these coating thicknesses more reliably, flame-cut surfaces should be ground off by the fabricator.

16. Sampling

The test specimens shall be selected at random from each lot. In this case, the minimum number of specimens from each lot shall be as follows (Table 16):

Number of pieces in Lot	Number of specimens
3 or less	ALL
4 to 500	3
501 to 1200	5
1201 to 3200	8
3201 to 10000	13
10001 and over	20

A lot is one or more articles of the same and size comprising a single order or a single delivery load, whichever is the smaller.

16.1. Reference areas

The number and position of reference areas and their sizes for the magnetic test shall be chosen with regard to the shapes and sizes of the article(s) in order to obtain a result as representative as possible of mean coating thickness or mass per unit area as applicable. On a long article in the control sample, the reference areas shall be cut approximately 100 mm from each end and the approximate center and shall comprise the whole cross-section of the article.

The number of reference areas, dependent upon the size of the individual articles in the control sample, shall be as follows:

a) For articles with significant surface area greater than 2m² (large articles):

At least three reference areas shall be taken on each article in the control sample. On each article (taken separately) in the control sample the mean coating thickness within the

reference area shall be equal or greater than the mean coating thickness values in Table 2.

b) For articles with significant surface area over 10,000 mm² and up to 2 m² (inclusive):

On each article in the control sample there shall be at least one reference area.

c) For articles with significant surface area between 1,000 mm² and 10,000 mm² (inclusive): On each article in the control sample there shall be one reference area.

d) For articles with less than 1,000 mm² significant surface area:

Enough articles shall be grouped together to provide at least 1,000 mm² surface for an individual reference area. The number of reference areas shall be as given in the last column of Table 1.

Hence the total number of articles tested equals the number of articles required to provide one reference area multiplied by the appropriate number from the last column of Table 1 related to the size of the lot (or the total number of articles galvanized if that is less).

*NOTE: 10,000 mm² = 100 cm²

1,000 mm² = 10 cm²

2 m² is typically 200cm x 100 cm

10,000 mm² is typically 10 cm x 10 cm

1,000 mm² is typically 10 cm x 1 cm

In cases b), c) and d), the thickness on each reference area shall be equal to or greater than the 'local coating thickness' values given in Table 2 as appropriate. The mean thickness on all reference areas in a sample shall be equal to or greater than the mean coating thickness values given in Table 2 as appropriate.

When more than five articles have to be taken to make up a reference area of at least 1,000 mm², a single magnetic measurement shall be taken on each article if a suitable area of

significant surface exists: if not, the gravimetric test shall be used.

Within each reference area, which should be at least 1,000 mm², a minimum of five magnetic test readings shall be taken coated areas. If any of the individual readings is lower than the values in Table2 (EN ISO 1461 Table 2) , this is irrelevant, as only the mean value over the whole of each reference area is required to be equal or greater than the local thickness given in the table. Thickness measurements shall not be taken on cut surfaces or areas less than 10 mm from edges, flame cut surfaces or corners.

17. Coating thickness:

The average of the thickness values taken for each specimen shall be not less than one coating thickness grade lower than the values listed in the appropriate specification. If these coating thickness measurements are made on an article with different thicknesses of steel, the values in the appropriate specification apply to each thickness of steel on the article.

To avoid possible sources of error in the use of electronic thickness testing gauge, certain precautions should be taken:

- Reading should not be taken near an edge, hole or inside corner.

- Readings should not be taken on curved surfaces without proper recalibration.

- The test surface should be free from dirt, grease, oxides and corrosion products.

- Test points should be chosen to avoid obvious peaks or irregularities in the coating.

- Minimum measuring value should be considered.

The electronic thickness testing gauge should be frequently recalibrated against non-magnetic film standards of known thickness.

The electronic thickness testing gauge has typical accuracies of plus or minus 5 percent.

Table 17 – Coating minimum thickness on samples that are not centrifuged (EN ISO 1461 Table D.1)		
Article and its thickness	**Local coating thickness (minimum) µm**	**Mean coating thickness (minimum) µm**
Steel ≥ 6 mm	70	85
3 mm to ≥ Steel < 6mm	55	70
1.5 mm to ≥ Steel < 3 mm	45	55
Steel < 1.5 mm	35	45
Castings ≥ 6 mm	70	80
Castings < 6mm	60	70

17.1. Acceptance criteria

When tested in accordance with Sec.7 for the appropriate number of reference areas given in Sec.8 the coating thickness shall be not less than the values given in Table 2 as appropriate. Except in the case of dispute, the non-destructive test shall be used unless the purchaser specifically accepts that his articles may be cut for mass loss determinations. Where articles include a number of different thicknesses of steel, each thickness range shall be regarded as a separate article and the relevant values in Tables 2, as appropriate, shall apply.

If the thickness of coating on a control sample does not conform to these requirements, twice the original number of articles (or all the articles if that is the lesser number) shall be taken from the lot and tested. If this larger control sample passes, the whole inspection lot shall be accepted. If the larger control sample does not pass, the articles that do not conform to the

requirements shall either be discarded or the purchaser may authorize them to be re galvanized.

18. Testing for adherence

Adhesion between zinc and basis metal generally does not need to be tested as adequate bonding is characteristic of the galvanizing process and the coated work should be able to withstand – without peeling or flaking – handling consistent with the nature and thickness of the coating and the normal use of the article. In general, thicker coatings require more careful handling than thinner coatings. Bending or forming after hot dip galvanizing are not considered to be normal handling.

Should it be necessary to test the adhesion, e.g. in the case of work pieces that are to be subject to high mechanical stresses, any test shall only be on significant surfaces, i.e. in areas in which good adhesion is important for the proposed application.

A crosshatch test will give some guidance on the mechanical properties of the coating but in some cases may be more demanding than the application requires. Other impingement tests and cutting tests may also be developed for hot dip galvanized coatings and will be further considered for possible eventual issue as a separate document.

One method is recognized for testing galvanized coatings for adhesion:

The stout knife test while it is not a true measure of the adhesive strength of the galvanized coating to the base steel, it serves as an indicator of the adherence properties of the coating.

19. After treatment

Normally articles should not be stacked together while hot or wet. Small articles dipping in bulk in baskets or on jigs may centrifuged immediately after withdrawal from the zinc to remove any surplus metal.

To retard the possible formation of wet storage stain on the surface, articles that are not to be

painted can be given a suitable surface treatment after hot dip galvanizing.

20. VISUAL INSPECTION

20.1. Appearance

At acceptance inspection, the significant surface(s) of all the hot dip galvanize article(s), when examined by normal corrected vision, shall be free from nodules, blisters (i.e. raised areas without solid metal beneath), roughness and sharp points (if they can cause injury) and uncoated areas.

The occurrence of darker or lighter area (e.g. cellular pattern or dark grey areas) or some surface unevenness shall not be cause for rejection, also wet storage stain (white or dark corrosion product – primarily basic zinc oxide – formed during storage in humid conditions after hot dip galvanizing) shall not be cause for rejection, providing the coating thickness remains above the specified minimum value.

- It is not possible to establish a definition of appearance and finish covering all requirements in practice.

Flux residues shall not be permitted. Lumps and zinc ash shall not be permitted where they may affect the intended use of the hot dip galvanized article or its corrosion resistance requirement.

Articles that fail visual inspection shall be renovated or re-galvanized and resubmitted for inspection.

20.2. Bare Spots

Because of zinc's sacrificial action, small localized flaws are somewhat self-healing and have little effect on the service life of coating. Where considered necessary, such spots may be repaired using one repairing method indicated in this procedure. Any unrepairable, uncoated areas should be rejected. Some of the causes of bare spots on galvanized steel are described

below.

20.2.1. Inadequate Surface Preparation

Thorough preparation n of the steel is the foundation of good galvanizing. Remnants of paint, oil, grease, scale, or rust are the most common causes of uncoated spots. Such residues are not wetted by the molten zinc and, therefore, prevent normal coating reactions.

Figure20. 1. Inadequate surface preparation

20.2.2. Welding Slag

Slag deposits from welding are resistant to normal pickling acids and must be completely removed before the work enters the galvanizing process. Grinding or grit-/sand-blasting are strongly recommended for this purpose and are more effective than hand-chipping and wire-brushing. These areas require repair.

Figure20.2 . Welding Slag

20.2.3. Rolling Defects in Steel

These defects may be broadly classified as discontinuities in the steel that have been closed and elongated during rolling but have not bonded. Examples are laminations, laps and folds, and non-metallic impurities rolled into metal surfaces. Defects of this type are sometimes detected before or after pickling, but may not become apparent until opened by the heat of the galvanizing bath. Minor flaws in the steel may be removed by local grinding, but little reclamation is possible where the steel surface is seriously defective.

20.2.4. Oxidized Steel

If the time between fluxing and galvanizing is prolonged or the drying temperature is too high, the corrosion protection afforded the cleaned steel by a pre-flux may be lost. This is indicated by a rusty appearance on the un-galvanized article. The appearance of the galvanized coating is similar, in extreme cases, to that resulting from under preparation.

20.2.5. Excess Aluminum

A condition sometimes referred to as “black spots” may occur if the aluminum content of a galvanizing bath on which a flux blanket is used becomes too high. Minimal trouble should be experienced if the aluminum content of the bath is maintained below approximately 0.01 percent, which is well above the range needed to brighten the coating.

20.3. Articles in Contact

The zinc in the galvanizing bath should have free access to all parts of the surface. Articles entering and passing through the galvanizing bath should not be in tight contact with each other.

20.3.1. General Roughness

A rough coating is usually caused by excessive growth or unevenness of the alloy layers. This condition is attributable to the steel's chemical composition or its original surface condition.

Since the irregularity of the alloy layers tends to increase with their thickness, heavy coatings are usually rougher than lighter ones. Where a heavy coating results, some degree of roughness may be unavoidable. The importance attached to surface roughness varies with the nature of the product. For certain articles, such as tube and pipe, which are sold largely on the basis of visual, appear, a smooth appearance may be essential. Also, where one surface is required to mate with another, such as pole line insulator caps, a rough coating may be detrimental to the intended product function or assembly. Such cases are the exception, however. In most instances, the degree of roughness is not critical. Provided it is within reason and adhesion is good, the material should be accepted.

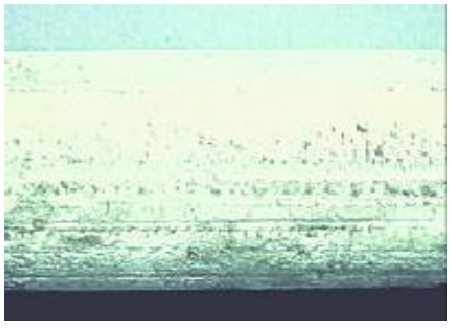


Figure20. 3.Rough, bumpy coatings

20.3.2. Dross Protrusions

Dross is the zinc-iron alloy that settles to the bottom of the zinc bath.

Dross inclusions in the coating resulting from agitation of the dross layer can produce surface protrusions. Because dross has a corrosion rate similar to zinc's, it has little effect on the normal life of the coating and its presence in the form of finely dispersed pimples is not seriously objectionable.

However, extensive dross inclusions are normally grounds for rejection since they tend to make the coating more susceptible to mechanical damage and may cause premature discoloration of the surface upon weathering.

Figure20. 4. Dross protrusions

20.3.3. Lumpiness and Runs

The coating's surface uniformity is controlled primarily by the drainage of the zinc as the work leaves the galvanizing bath. A lumpy and uneven coating result when the rate of withdrawal is too fast or when the bath temperature is too low to allow molten zinc to drain back into the bath as the item is removed. Excessive zinc may also occur because of delayed drainage from bolt holes, folds, seams and other pockets where zinc collects, and is a direct consequence of product design. The additional zinc, though wasteful, is clearly not detrimental except in those instances where a smooth finish is essential. A similar effect may result when articles are withdrawn in contact with each other.

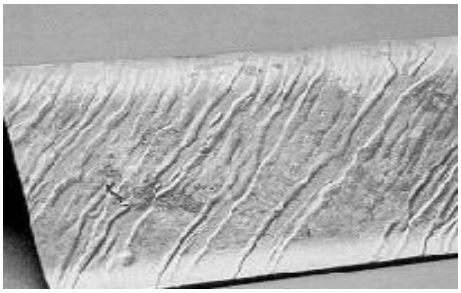


Figure 20.5. Lumpiness and runs

20.3.4. Flux Inclusions

Flux inclusions occur when the wet galvanizing process is employed. In the wet process, a layer of zinc-ammonium chloride is floated on top of the molten zinc. The material to be galvanized passes through the flux immediately prior to immersion in the zinc bath. The flux is carefully pushed to the side in order for the item to be removed. Flux inclusions may originate in several ways. Stale kettle flux, for example, tends to adhere to the steel instead of separating cleanly from the surface as the work is dipped. This may occur even with active flux if residual grease, scale, or other surface contaminants, which resist the cleansing action of the flux blanket, are present. In both instances, the inclusions are often associated with bare spots in the coating. Resulting black spots formed by the included flux particles are flux is removed.

Figure 20.6. Flux inclusion

20.3.5. Ash Inclusions

Zinc ash is the oxide film that develops on the surface of the galvanizing bath. As with flux, ash may be burnt on the steel during dipping or picked up from the top of the bath during withdrawal. Ash inclusions can occur on work that is cumbersome and requires slow withdrawal from the bath. This ash has no adverse effect on service life. Zinc ash that is not detrimental to the appearance of the finished product or that does not interfere with the product's function is not cause for rejection. Gross oxide lumps due to improper skimming of the exit surface of the bath can reduce the effective thickness of the coating and are unacceptable.

Figure 20.7. Ash Inclusions

20.3.6. Matte Gray or Mottled Coating

This condition develops during cooling and is caused by lack of a free zinc layer on the coating surface. It usually appears as a localized dull patch or spider web-like area on an otherwise normal surface; although in extreme cases it may extend over the entire surface of the steel. It is not cause for rejection unless specifically stated and agreed to by the galvanizer and the fabricator.

A matte gray coating is most frequently found on heavy sections that cool slowly, with certain types of steel, such as those with relatively high silicon or phosphorus content, or severely

cold-worked steel, all of which may exhibit abnormally rapid alloy growth.

Where the condition is caused by the nature of the base steel, the galvanizer has no control over its occurrence. Galvanizers generally do not have prior knowledge of steel's chemical composition. A lower galvanizing temperature and shorter immersion time followed (if the type of product is suitable) by rapid quenching in water to arrest the alloy growth may be successful in marginal cases. However, such measures are not always effective and matte areas in the coating may be unavoidable.

Due to the steel's chemical nature, these coatings are often thicker than the bright galvanized coatings and provide service life in proportion to the increased thickness. After exposure, these coatings may take on a light yellow to brown dusty appearance as the alloy layers weather. The appearance of this light residue colored by the iron content of the corrosion-resistant layers should not be considered a sign of failure.

20.3.7. Rust Stains

These are caused by seepage from joints and seams after galvanizing or by material being stored under or in contact with rusty steel. Rust stains of this type are superficial and should not be confused with failure of the underlying coating. Rust stains caused by seepage from an assembly can indicate a need for a modification of the design. Surface rust stains are not cause for rejection of the galvanized product.

20.3.8. Wet Storage Stain

Wet storage stain is the buildup of zinc oxide and zinc hydroxides on the galvanized surface. As the name implies, wet storage stain occurs when the steel is exposed to a humid or moist environment without access to freely circulating air.

Tightly stacked or nested galvanized items are particularly vulnerable to wet storage stain, especially if they are stored as unopened bundles for more than a few weeks.

Although in extreme cases the protective value of the coating may be impaired, attack is often superficial, despite the relative bulkiness of the zinc hydroxide.

Where the surface staining is light and smooth without growth of the zinc oxide layer, as judged by lightly rubbing fingertips across the surface, the staining will gradually disappear and blend in with the surrounding zinc surface as a result of normal weathering in service. If the affected area is not fully exposed in service or is subject to a humid environment, wet storage stain must be removed, even if it is superficial, to allow formation of the basic zinc carbonate film, which normally contributes to the corrosion resistance of the galvanized coating.

Medium to heavy buildup of white corrosion product must be removed; otherwise, the essential protective film of basic zinc carbonates cannot form in affected area. Light deposits can be removed by brushing with a stiff bristle (not wire) brush. A coating thickness check should be performed on the affected areas to ensure that sufficient zinc coating remains after the removal of the wet storage stain.

Figure 20.8. Dark gray area

Figure 20.9. Typical coating

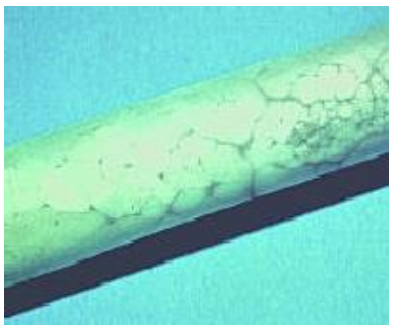


Figure 20.10. Mottled, Spider Web like

In advanced stages of wet storage stain, the typical white or gray corrosion product may blacken. When this occurs, a significant amount of coating has been lost to corrosion and the service life is decreased.

In extreme cases where heavy white deposits or red rust have formed as a result of prolonged storage under poor conditions, corrosion products must be removed and the damaged area

repaired as detailed in ASTM A 780.

Where the affected area is extensive, or when the wet storage stain would impair the use of the article for its intended service, re-galvanizing may be necessary.

Unless present prior to shipment from the galvanizer, the development of wet storage stain is not cause for rejection. The customer must exercise proper caution during transportation and storage to protect against wet storage stain.

21. TOUCH-UP AND REPAIR

21.1. When is Touch-up Necessary?

Occasionally during the hot-dip galvanizing process, bare spots or minor imperfections may occur that, if allowed to go un-repaired, will allow base metal corrosion. Sometimes after leaving the galvanizer's plant, the coating is damaged during shipping or by welding during field erection. If the total area is less than ½ of 1% of the surface area to be coated on the article the area may be repaired. If the area to be repaired exceeds those limits, the material must be re-galvanized.

21.2. Touch-up and repair the bare spot or damaged area with thermal zinc spraying

Renovation shall be by thermal zinc spraying (EN 22063 is relevant) or by a suitable zinc rich paint within the practical limits of such systems.

The treatment shall include the removal of any scale, cleaning and any necessary pretreatment to ensure adhesion.

21.2.1 Surface Preparation

According to ASTM-A780, the surface to be reconditioned shall be free of oil, grease, weld flux residue, and weld spatter and corrosion products. The blast cleaning must extend into the surrounding undamaged galvanized coating.

21.2.2. Application

Zinc spraying of the clean, dry surface by skilled workers should take place as soon as possible after preparation (within four hours) and prior to development of visible oxides. Spraying in horizontal overlapping lines yields a more uniform thickness than the cross-hatch technique. The zinc coating can be sealed with a thin coating of low viscosity polyurethane, epoxy-phenolic, epoxy, or vinyl resin. For details of the application sequence and procedures, consult ANSI/AWS C2.18-93.

Zinc spraying can be done either in the galvanizer's plant or on the job site, but the transport of blasting and metal spraying equipment to the job site may make it uneconomical compared to other touch-up and repair methods. If high humidity conditions exist during spraying, adhesion may be degraded.

21.2.3 Coating Thickness:

The coating thickness of the renovated area shall be at least 30 micrometers more than the local coating thickness requirements in table 2 or 3 for the relevant hot dip galvanized coating.

21.2.4. Coating Appearance:

The surface of the sprayed zinc coating on the repair area should be free of lumps, coarse areas and loose particles.

21.2.5. Adhesion:

Adhesion of the zinc spray to the base metal is by mechanical means and is dependent on the quality of surface preparation and cleaning. The higher the surface profile, the better the mechanical bond. Adhesion values of 1000 psi are typical. The temperature of the zinc upon impact with the base metal is not high enough to result in the alloy coating produced by hot dipping.

21.2.6. Abrasion Resistance:

Abrasion resistance of zinc spray coatings is moderate compared to hot-dip galvanized surfaces.

21.2.7. Mechanical Properties:

The relatively low temperature of application has no adverse effect on the steel properties. Metallizing does improve some properties such as surface frictional coefficients and corrosion fatigue resistance.

21.2.8. High Temperature:

Sprayed zinc coatings are suitable for constant exposures up to approximately 390 ºF (200 ºC) and short-term exposure at higher temperatures.

Project Name / Dtt Job No :

Reference Document Name / No:

Item No : **Header No:**

SAND BLASTING :

Blast Material : **Accept** ☐

Surface Preparation : **Accept** ☐

PAINTING :

Primer Coat : **D.F.T :** **µ**

Max Thk.= **Min Thk.=** **Average Thk.=** **Accept** ☐

Inter mediate Coat : **D.F.T :** **µ**

Max Thk.= **Min Thk.=** **Average Thk.=** **Accept** ☐

Finish Coat : **D.F.T :** **µ**

Max Thk.= **Min Thk.=** **Average Thk.=** **Accept** ☐

TOTAL DRY FILM (DFT) :

ADHESION :

Adhesion Accordance to :

Primer Coat: **Accept** ☐ **Intermediate Coat :** **Accept** ☐ **Finish Coat :** **Accept** ☐

Instrument for paint thickness measurment :

Vendor	Contractor	TPI	Client
Name :	Name :	Name :	Name :
Date :	Date :	Date :	Date :
Sign	Sign	Sign	Sign

Code: QF19 Rev.1