



# ASSAM PETRO-CHEMICALS LIMITED

(A Government of Assam Undertaking) | An ISO 9001:2008 Certified Company  
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## Corrigendum - 2

Name of Work: Transshipment facility works of APL at Boitamari, Assam

Tender Number: TCE.6842A-CV-3000-3004 dated 16th October, 2019

The modification/ additional information of the above mentioned Tender document is attached here.

**Sd/-  
Managing Director**

**PAINTING SPECIFICATION**

FILE NAME: TCE.6842A-CV-3000-3004-20\_1-Rev-P0.DOCX

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**Abbreviations:**

AS	:	Alloy Steel
CS	:	Carbon Steel
DFT	:	Dry Film Thickness
DM	:	De-mineralized
GI	:	Galvanized Iron
ID	:	Internal Diameter
IRN	:	Inspection Release Note
LTCS	:	Low Temperature Carbon Steel
MS	:	Mild Steel
NB	:	Nominal Bore
OD	:	Outside Diameter
RCC	:	Reinforced Cement Concrete
SS	:	Stainless Steel
WFT	:	Wet Film Thickness

## CONTENTS

SL. NO	DESCRIPTION	PAGE NO.
1.0	General.....	4
2.0	Scope.....	4
3.0	Reference Codes & Standards.....	6
4.0	Equipment.....	7
5.0	Surface Preparation, Shop Primer, Coating Application & Repair and Documentation..	7
6.0	Paint Materials.....	16
7.0	Coating Systems selection criteria.....	21
8.0	Coating System for Gratings, Rolling & Stationery Ladders, Spiral Stairways and Hand Rails in All Location.....	23
9.0	Coating System for Offsite Area (Inland Plants).....	24
10.0	Coating System For Unit Areas as well as DM, CPP, Cooling Tower of Inland Plants and for All Areas (Unit, Offsite, DM, CPP, etc.) of Coastal Plants.....	25
11.0	Coating System for Effluent Treatment Plant (ETP).....	27
12.0	External Coating Systems for Uninsulated Carbon Steel and Alloy Steel Storage Tanks (For All Plant Locations, Coastal or Inland) - All Process Units & Off-Sites ....	28
13.0	Internal Coating Systems for Carbon Steel and Alloy Storage Tanks - All Process Units & Off-Sites.....	30
14.0	Coating Systems for External Side of Underground Carbon Steel Plant Piping and Underground Vessels.....	32
15.0	Coating Under Insulation (Coastal Or Inland Plants). All Units Areas & Off-Sites.....	33
16.0	Coating System for Carbon Steel Components of Coolers / Condensers (Internal Protection) for Fresh Water Service.....	34
17.0	Coating System (Internal Protection) for Galvanized or Non Ferrous or Stainless Steel/ Duplex Stainless Steel Components of Coolers/ Condensers for Fresh Water Service.....	35
18.0	Storage.....	35
19.0	Paint colour code for piping and equipment .....	35
20.0	Recommended paint colour code .....	38
21.0	Painting for civil defense requirements.....	43
22.0	Quality Control, Inspection and Testing.....	44
23.0	Guarantee.....	47
24.0	Qualification Criteria of Painting Contractor/Sub-Contractor.....	47
25.0	Qualification/Acceptance Criteria for Paint Coating System.....	47
26.0	Method of Sampling & Dispatch for Laboratory Testing.....	50

## **1.0 GENERAL**

**1.1** This technical specifications shall be applicable for the work covered by the contract, and without prejudice to the provisions of various international codes of practice, standard specifications etc. It is understood that contractor shall carry out the work in all respects with the best quality of materials and workmanship and in accordance with the best engineering practice and instructions of Engineer-In-Charge.

**1.2** Wherever it is stated in the specification that a specific material is to be supplied or a specific work is to be done, it shall be deemed that the same shall be supplied or carried out by the contractor.

Any deviation from this standard without written deviation permit from appropriate authority will result in rejection of job.

**1.3 This specification covers the requirement for protective coating for new construction.**

## **2.0 SCOPE**

**2.1** Scope of work covered in the specification shall include, without being limited to the following.

**2.1.1** This specification defines the requirements for surface preparation, selection and application of primers and paints on external surfaces of equipment, vessels, machinery, piping, ducts, steel structures, external & internal protection of storage tanks for all services and chimneys if any. The items listed in the heading of tables of paint systems is indicative only, however, the contractor is fully responsible for carrying out all the necessary painting, coating and lining on external and internal surfaces as per the tender requirement.

### **2.2 Extent of Work**

**2.2.1** The following surfaces and materials shall require shop, pre-erection and field painting

- All uninsulated Carbon Steel & Alloy Steel equipments like vessels, Columns, storage Tanks, Exchangers if any, parts of boilers etc.
- All uninsulated carbon steel and alloy plant and related piping, fittings and valves (including painting of identification marks), furnace ducts and stacks.
- All insulated parts of vessels, boilers, chimneys, stacks, piping and steam piping and if any other insulated items present.
- All items contained in a package unit as necessary.
- All structural steel work, pipe, structural steel supports, walkways, handrails, ladders, platforms etc.
- Flare lines, external surfaces of MS chimney with or without refractory lining and internal surfaces of MS chimney without refractory lining. (If present)

- Identification of colour bands on all piping as required including insulated aluminium clad, galvanized, SS and nonferrous piping.
- Identification lettering/ numbering on all painted surfaces of equipment/piping insulated aluminium clad, galvanized, SS and non-ferrous piping.
- Marking / identification signs on painted surfaces of equipment/piping including hazardous service.
- Supply of all primers, paints and all other materials required for painting (other than Owner supplied materials)
- Over insulation surface of equipments and pipes wherever required.
- Painting under insulation for carbon steel, alloy steels and stainless steel as specified.
- Painting of pre-erection/fabrication and Shop primer.
- Repair work of damaged pre-erection/ fabrication and shop primer and weld joints in the field/site before and after erection as required.
- All CS Piping, equipments, storage tanks and internal surfaces of RCC tanks in ETP plant.
- Quality control, testing and inspection during all stages of work (surface preparation, application of coating and testing of furnished coating).

2.2.2 The following surfaces and materials shall not require painting in general. However, if there is any specific requirement by the OWNER, the same shall be painted as per the relevant and applicable specifications.

- a. Uninsulated austenitic stainless steel.
- b. Plastic and/or plastic coated materials
- c. Non-ferrous materials like aluminum, Cu-Ni alloy
- d. Galvanized steel.

In general Galvanized steel doesn't require painting. However if as per OWNERs instructions, contractual or for colour coding requirement painting is essential then coating system in table 8.0 shall be followed.

## 2.3 Documents

2.3.1 The contractor shall perform the work in accordance with the following documents issued to him for execution of work.

- a. Bill of quantities for piping, equipment, machinery and structures etc.
- b. Piping Line List.
- c. Painting specifications including special civil defense requirements.

**2.4** Unless otherwise instructed, final paint coating (i.e., application of field primer, wherever required, intermediate and top coats) on pre-erection/ shop primed equipments shall be applied at site, only after all welding, testing on systems are completed as well as after completion of steam purging wherever required.

**2.5** Changes and deviations required for any specific job due to clients requirement or otherwise shall be referred to deviation permit.

### **3.0 REFERENCE CODES & STANDARDS**

**3.1** Without prejudice to the provision of Clause 1.1 above and the detailed specifications of the contract, latest editions of the following codes and standards are applicable for the work covered by this contract.

IS-5	:	Colour coding
RAL DUTCH	:	International Standard for colour shade (Dutch Standard)
IS-101	:	Methods of test for ready mixed paints and enamels
IS-2379	:	Indian Standard for Pipe line identification-colour code
ISO-12944	:	Corrosion Protection of steel Structures by Protective Paint System
ASTM-Vol 6.01&6.03	:	American standard test methods for Paints and Coatings.
ANSI A 13.1	:	Scheme for identification of piping systems: American National Standards Institution
SSPC	:	Steel Structures Painting Council

### **3.2 Surface Preparation Standards**

The latest editions of any of the following standards shall be followed for surface preparation:

**3.2.1** ISO 8501-1 / SIS-05 59 00: ISO standard for Preparation of steel substrates before application of paints and related products. This standard contains photographs of the various standards on four different degrees of rusted steel and as such is preferable for inspection purpose by the Engineer-In-Charge.

**3.2.2** Steel Structures Painting Council, U.S.A. (Surface Preparation Specifications (SSPC-SP).

**3.2.3** National Association of Corrosion Engineers, U.S.A., (NACE).

**3.2.4** Various International Standards equivalent to Swedish Standard for surface preparations are given in Table-I.

**3.3** The contractor shall arrange, at his own cost, to keep a set of latest edition of above standards and codes at site.

**3.4** The paint manufacturer's instructions shall be followed as far as practicable at all times for best results. Particular attention shall be paid to the following:

a. Instructions for storage to avoid exposure as well as extremes of temperature.

b. Surface preparation prior to painting shall be followed as per Table 8.0 to 16.0 of this standard shall be followed.

- c. Mixing and thinning.
- d. Application of paints and recommended limit on time intervals in between coats.

## **4.0 EQUIPMENT**

**4.1** All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning and all equipments, scaffolding materials, shot & grit blasting equipments & air compressors etc. required to be used shall be suitable for the work and all in good order and shall be arranged by the contractor at site and in sufficient quantity. The manufacturer's test certificates / data sheets for all the above items shall be reviewed by Engineer-in-charge at site before start of work.

**4.2** Mechanical mixer shall be used for paint mixing operations in case of two pack systems except that the Engineer-In-Charge may allow the hand mixing of small quantities at his discretion in case of specific requirement for touch up work only.

## **5.0 SURFACE PREPARATION, SHOP PRIMER COATING APPLICATION & REPAIR AND DOCUMENTATION**

### **5.1 General**

**5.1.1** In order to achieve the maximum durability, one or more of following methods of surface preparation shall be followed, depending on condition of surface to be painted and as instructed by Engineer-In-Charge. Adhesion of the paint film to surface depends largely on the degree of cleanliness of the metal surface. Proper surface preparation contributes more to the success of the paint protective system.

- a. Abrasive blast cleaning
- b. Mechanical or power tool cleaning

**5.1.2** Mill scale, rust, rust scale and foreign matter shall be removed fully to ensure that a clean and dry surface is obtained. Unless otherwise specified, surface preparation shall be done as per provisions of relevant tables given elsewhere in this specification. The minimum acceptable standard, in case of thermally sprayed metal coatings, in case of mechanical or power tool cleaning it shall be St. 3 or equivalent. In case of blast cleaning it shall be Sa 2-1/2 as per Swedish Standard SIS-055900 (latest edition) or SSPC-SP or ISO 8501-01. Blast cleaning shall be Sa 3 as per Swedish Standard in case thermally sprayed metal coatings.

Before surface preparation by blast cleaning, the surface shall be degreased by aromatic solvent to remove all grease, oil etc.

**5.1.3** Irrespective of whether external or internal surface to be coated, blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceed 85%. In case of internal coating of storage tanks, dehumidifier shall be used, to control humidity level below 60%. Dehumidifier should depress the dew point of air in the enclosed space, sufficient enough so as to maintain it 3°C below the metal substrate temperature during centre period of blasting and coating application. During the interval time between application of primer coat and subsequent intermediate and top coats or between blast cleaning completion and start of application of



primer coat, dehumidifier unit should be in continuous operation to ensure that no condensation occurs on substrate.

Dehumidifier should be able to maintain grain drop (moisture removal) at the rate of 25 grains per pound of air per hour. Dehumidifier should have capacity of at least 2 air changes per hour of the enclosed space. All necessary psychometric data should be collected by contractor for the given site conditions before starting operation of dehumidifier to ensure that desired values of dew point, moisture content in enclosed scope is achieved.

Dehumidification to be maintained round the clock for surface preparation and painting till the total coating application is over.

Dehumidifier shall not be stopped under any condition till the entire blasted surface is primed to the satisfaction of the technical representative of the paint manufacturer interested with quality assurance for the work. In case the dehumidifier breaks down in middle of the job, the same shall be replaced at the risk and the cost of the contractor and the entire unfinished work shall be repeated.

5.1.4 The Engineer in-charge shall have the right to disallow usage of dehumidifier if the performance is not meeting the specified requirements. Under such circumstances the contractor shall remove the equipment and replace the same with another equipment to provide satisfactory results without any additional cost to the owner.

5.1.5 Irrespective of the method of surface preparation, the first coat of primer must be applied by airless spray/ air assisted conventional spray if recommended by the paint manufacturer on dry surface. This should be done immediately and in any case within 4 hours of cleaning of surface. However, at times of unfavorable weather conditions, the Engineer-In-Charge shall have the liberty to control the time period, at his sole discretion and/or to insist on re-cleaning, as may be required, before primer application is taken up. In general, during unfavorable weather conditions, blasting and painting shall be avoided as far as practicable.

5.1.6 The external surface of R.C.C. chimney to be painted shall be dry and clean. Any loose particle of sand, cement, aggregate etc. shall be removed by scrubbing with soft wire brush. Acid etching with 10-15% HCL solution for about 15 minutes shall be carried and surface must be thoroughly washed with water to remove acid & loose particles and then dried completely before application of paint.

## **5.2 Procedure for Surface Preparation**

### **5.2.1 Air Blast Cleaning with abrasives**

The surfaces shall be blast cleaned using one of the abrasives like angular chilled cast iron or steel grit, copper slag or Nickel slag,  $Al_2O_3$  particles at pressure of  $7kg/cm^2$  at an appropriate distance and angle depending of nozzle size maintaining constant velocity and pressure. Chilled cast iron or steel shall be in the form of shot or grit of size in the range of G16 – G42 conforming to SSPC AB1 and S250 grade size of steel shots (maximum) to obtain a desired surface profile of 35-50 microns trough to peak. For all other abrasives, size shall be in the range of G16 – G24. The combination of steel grits and shots shall be normally in the ratio of 3:1. The quality of abrasives shall be free from contaminants and impurities and shall meet the requirements of SSPC AB1. Compressed air shall be free from moisture and oil. The blasting nozzles should be venturi style with tungsten carbide or boron carbide as the materials for liners. Nozzles orifice may vary from 3/16" to 3/4". On completion of blasting

operation, the blasted surface shall be clean and free from any scale or rust and must show a grey white metallic luster. Primer/first coat of paint shall be applied within 4 hours of surface preparation. Blast cleaning shall not be done outdoors in bad weather without adequate protection or when there is dew on the metal, which is to be cleaned. Surface profile shall be uniform to provide good key to the paint adhesion (i.e. 35 to 50 microns). If possible vacuum collector shall be installed for collecting the abrasives and recycling.

### 5.2.2 **Mechanical or Power Tool Cleaning**

Power tool cleaning shall be done by mechanical striking tools, chipping hammers, grinding wheels or rotating steel wire-brushes. Excessive burnish of surface shall be avoided as it can reduce paint adhesion. On completion of cleaning, the detached rust mill scale etc. shall be removed by clean rags and /or washed by water or steam and thoroughly dried with compressed air jet before application of paint.

### 5.3 **Non-Compatible Shop Coat Primer**

For equipments on which application of total protective coating (Primer + Intermediate + top coat) is carried out at shop, compatibility of finish coat with primer should be checked with paint manufacturer. If the shop coat is in satisfactory condition showing no major defect upon arrival at site, the shop coat shall not be removed.

5.4 Shop coated equipments (coated with Primer & finishing coat) should not be repainted unless paint is damaged. Repair shall be carried out as per Table 7.2 of paint systems depending upon compatibility of paint.

5.5 Shop primed equipment and surfaces will only be 'spot cleaned' in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer should be completely removed before application of selected paint system for particular environment.

5.6 For Package units/equipment, shop primer should be as per the paint system given in this specification. However, manufacturer's standard can be followed after review.

As mentioned in section 2.4, all coating application at field (field primer, intermediate and top coat) on equipments, structures, piping, etc, shall be carried out only after its erection and all welding, testing, steam purging (wherever carried out) have been completed.

### 5.7 **Coating Procedure and Application**

**All paint coatings shall be applied by airless spray excepting at the following special cases where application can be carried out by brush subject to suitability of the application of the paint product by brush.**

- Spot repair
- Stripe coating on edges
- Small bore parts not suitable for spray application.

**Irregular surfaces such as sharp edges, welds, small brackets, and interstices may stripe coated to ensure specified DFT is achieved. Paint manufacturer recommendation should be followed before deciding for brush application.**

- 5.7.1 Surface shall not be coated in rain, wind or in environment where injurious airborne elements exists, when the steel surface temperature is less than 5°F above dew point when the relative humidity is greater than 85% or when the temperature is below 40°F and when the ambient/substrate temp is below the paint manufacturer's recommended temperature of application and curing. De-humidifier equipment shall be used to control RH and Dew point. The paint application shall not be done when the wind speed exceeds 20km per hour.
- 5.7.2 Blast cleaned surface shall be coated with one complete application of primer as soon as practicable but in no case later than 4 hrs the same day.
- 5.7.3 To the maximum extent practicable, each coat of material shall be applied as a continuous film uniform thickness free of probes. Any spots or areas missed in application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.
- 5.7.4 Each coat shall be in proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for recoating when an additional coat can be applied without the development of any detrimental film irregularities, such as lifting or loss of adhesion of the under coat. Manufacturer instruction shall be followed for inter coat interval.
- 5.7.5 When the successive coat of the same colour have been specified, alternate coat shall be tinted, when practical, sufficiently to produce enough contrast to indicate complete coverage of the surface. The tinting material shall be compatible with the material and not detrimental to its service life and shall be recommended by the original paint manufacturer.
- 5.7.6 Airless spray application shall be in accordance with the following procedure: as per steel structure paint Manual Vol.1 & Vol.2 by SSPC, USA, Air less spray relies on hydraulic pressure rather than air atomization to produce the desired spray. An air compressor or electric motor is used to operate a pump to produce pressures of 1000 to 6000 psi. paint is delivered to the spray gun at this pressure through a single hose within the gun, a single paint stream is divided into separate streams, which are forced through a small orifice resulting in atomization of paint without the use of air. This results in more rapid coverage with less over spray. Airless spray usually is faster, cleaner, more economical and easier to use than conventional air spray.

Airless spray equipment is mounted on wheels, and paint is aspirated in a hose that sucks paint from any container, including drums. The unit shall have in built agitator that keep the paint uniformly mixed during the spraying. The unit shall consist of in built strainer. Usually very small quantity of thinning is required before spray. In case of high build epoxy coating (two pack). 30:1 pump ratio and 0.020-0.023" tip size will provide a good spray pattern. Ideally fluid hoses should not be less than 3/8" ID and not longer than 50 ft to obtain optimum results.

In case of gun choking, de-choking steps shall be followed immediately.

- 5.7.7 Brush application of paint shall be in accordance with the following:
- a. Brushes shall be of a style and quality that will enable proper application of paint.
  - b. Round or oval brushes are most suitable for rivets, bolts, irregular surface, and rough or pitted steel. Wide flat brushes are suitable for large flat areas, but they shall not have width over five inches.

- c. Paint shall be applied into all corners.
- d. Any runs or sags shall be brushed out.
- e. There shall be a minimum of brush marks left in the applied paint.
- f. Surfaces not accessible to brushes shall be painted by spray, doublers, or sheepskin.

5.7.8 For each coat the painter should know the WFT corresponding to the specified DFT and standardize the paint application technique to achieve the desired WFT. This has to be ensured in the qualification trial.

## 5.8 Drying of Coated Surfaces

5.8.1 No coat shall be applied until the preceding coat has dried. The material shall be considered dry for re-coating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats. Drying time of the applied coat should not exceed maximum specified for it as a first coat; if it exceeds the paint material has possibly deteriorated or maxing is faulty.

5.8.2 No paint shall be force dried under conditions which will cause chalking, wrinkling, blistering formation of pores, or detrimentally affect the conditions of the paint.

5.8.3 No drier shall be added to paint on the job unless specifically called for in the manufacturer's specification for the paint.

5.8.4 Paint shall be protected from rain, condensation, contamination, snow and freezing until dry to the fullest extent practicable.

## 5.9 Spot Repair of Damaged Primer

5.9.1 Where pre erection shop primer has been damaged at isolated localized spots during handling and transportation, or after erection / welding, the repair of damaged coating of pre-erection / pre-fabrication or shop primer shall be done as given below and as per the Table 7.2 of this specification.

5.9.2 **Repair of damaged inorganic zinc silicate pre-erection / pre-fabrication or shop primer (F9) after erection / welding in the design temperature of -90°C to 400°C and damaged silicone aluminium (F-12) pre-erection / pre-fabrication or shop primer after erection / welding for design temperature range of 401 – 550 °C.**

Surface Preparation: Quickly remove the primer from damaged area by mechanical scraping and emery paper conforming to SSPC-SP-3 to expose the white metal. Blast clean the surface, if possible. Feather the primed surface over the intact adjacent surface surrounding the damaged area by emery paper.

Primer coating: One coat of F-9 shall be applied wherever damage was observed on pre-erection / pre fabrication or shop primer of inorganic zinc silicate coating (F-9). Similarly one coat of F-12 shall be applied wherever damage observed on pre-erection / pre-fabrication shop primer of silicone aluminium (F-12).

5.9.3 Wherever if damaged areas are found extensive and spread over large areas, then entire pre-erection / pre-fabrication or shop primer shall be removed by blasting to achieve SSPC-SP-10 then entire blasted surface shall be primed again with F-9 or F-12 as applicable for the intended design temp. (See note under table 7.2).

## **5.10 Paint Application**

- 5.10.1 Shop priming/pre-erection priming with F9 or F12 shall be done only on blasted surface (SSPC-SP-10)
- 5.10.2 Shop priming / pre-erection priming with F9 or F12 shall be done only with airless spray.
- 5.10.3 **Assessment of Painting Requirement**

The paint system to be applied for a specific job shall be arrived at sequentially as given below:

- Identify the environment from area classification details and chose the appropriate table.
- Identify the design temperature from the technical documents
- Identify the specific field paint system and surface preparation requirement from the above identified table and temperature range.
- Identify the shop priming requirement from Table 7.1 based on compatibility of the above paint system.
- Identify the need of repair of shop primer and execute as per Table 7.2.

## **5.11 Documentation / Records**

- 5.11.1 A written quality plan with procedure for qualification trials and for the actual work including test and inspection plan & procedure for approval before start of work.
- 5.11.2 Daily progress report with details of weather conditions, particular of applications, no of coats and type of materials applied, anomalies, progress of work versus program.
- 5.11.3 Results of measurement of temperatures relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority.
- 5.11.4 Particulars of surface preparation and paint application during trials and during the work.
- 5.11.5 Details of non-compliance, rejects and repairs.
- 5.11.6 Type of testing equipments and calibration.
- 5.11.7 Code and batch numbers of paint materials used.

The coating applicator must maintain a job record consisting of all the information as per 5.11.2 -5.11.7 above as well as the approved procedure of work (5.11.1 above). The job record consisting of information as required in accordance to 5.11.2 – 5.11.7 shall be entered on daily basis and should be daily signed by Engineer-in-charge.

**TABLE-1 (FOR CLAUSE 5.0)****SURFACE PREPARATION STANDARDS**

Sl. No.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)			REMARKS
		ISO 8501-1/ SIS-05 59 00	SSPC-SP, USA	NACE, USA	
1	Manual or hand tool cleaning  Removal of loose rust, loose mill scale and loose paint, chipping, scrapping, standing and wire brushing. Surface should have a faint metallic sheen	ST.2	SSPC-SP-2	--	This method is applied when the surface is exposed to normal atmospheric conditions when other methods cannot be adopted and also for spot cleaning during maintenance painting.
2	Mechanical or power tool cleaning  Removal of loose rust loose mill scale and loose paint to degree specified by power tool chipping, de-scaling, sanding, wire brushing and grinding, after removal of dust, surface should have a pronounced metallic sheen.	ST.3	SSPC-SP-3	--	
3	Dry abrasive Blast cleaning  There are four common grades of blast cleaning				
3.1	White metal  Blast cleaning to white metal cleanliness. Removal of all visible rust. Mill scale, paint & foreign matter 100% cleanliness with desired surface profile.	SA 3	SSPC-SP-5	NACE#1	Where extremely clean surface can be expected for prolong life of paint system.
3.2	Near white metal  Blast cleaning to near white metal cleanliness, until at least 95% of each element of surface area is free of all visible residues with desired surface profile.	SA 2½	SSPC-SP-10	NACE#2	The minimum requirement for chemically resistant paint systems such as epoxy, vinyl, polyurethane based and inorganic zinc silicate paints, also for conventional paint systems used under fairly corrosive conditions to obtain desired life of paint system.

Sl. No.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)			REMARKS
		ISO 8501-1/ SIS-05 59 00	SSPC-SP, USA	NACE, USA	
3.3	Commercial Blast  Blast cleaning until at least two-third of each element of surface area is free of all visible residues with desired surface profile.	SA 2	SSPC-SP-6	NO.3	For steel required to be painted with conventional paints for exposure to mildly corrosive atmosphere for longer life of the paint systems.
3.4	Brush-off Blast  Blast cleaning to white metal cleanliness, removal of all visible rust, mill scale, paint & foreign matter. Surface profile is not so important	SA 1	SSPC-SP-7	NO.4	

## 6.0 PAINT MATERIALS

Paint manufacturers shall furnish the characteristics of all paints materials on original printed literature, along with the test certificate for all specified characteristics given in this specification. All the paint materials shall be of first quality and conform to the following general characteristics as per the tables 6.1, 6.2, 6.3 and 6.4.

### PAINT MATERIALS

**TABLE No. 6.1 PRIMERS**

Sl. No.	DESCRIPTION	P-2	P-4	P-6	P-7
1	Technical name	Chlorinated rubber Zinc Phosphate primer.	Etch primer/wash primer	Epoxy zinc phosphate primer	ZINGA, LOCKTITE or ZRC cold galvanizing
2	Type and composition	Single pack, air drying chlorinated rubber based medium plasticised with unsaponifiable plasticizer, pigmented with zinc phosphate.	Two pack polyvinyl butyral resin medium cured with phosphoric acid solution pigmented with zinc tetroxy chromate.	Two component polyamine cured epoxy resin medium, pigmented with zinc phosphate.	One pack Synthetic Resin based zinc galvanizing containing min 92% of electrolytic zinc dust of 99.95% purity.
3	Volume Solids %	40 ±3	10±1	50±1	37%
4	DFT (Dry Film thickness) per coat in microns	40-45	8-10	40-50	40-50µ
5	Theoretical covering capacity in M <sup>2</sup> /coat/ litre	8-10	8-10	8-10	4m <sup>2</sup> /kg
6	Weight per litre in kgs/litre	1.3±0.05	1.2±0.05	1.4±0.05	2.67 kg at 15°C
7	Touch dry at 30°C (minimum)	30 minutes	2 hrs.	After 30 min.	10 minutes
8	Hard dry at 30°C (maximum.)	8 hrs.	24 hrs.	8 hrs	24 hrs.
9	Overcoating interval	Min.: 8 hrs	Min: 4-6 hrs.	Min.:8hrs.	Min.:4 hrs
10	Pot life at 30°C for two component paints	Not Applicable	Not applicable	6 - 8 hrs.	Unlimited
11	Temperature (Resistance (minimum)	60°C Dry service	NA Dry service	80°C Dry service	50°C Dry service



## PAINT MATERIALS

### TABLE No. 6.2 FINISH PAINTS

Sl. No	DESCRIPTION	F-2	F-3	F-6A/B	F-6C	F-7
1	Technical name	Acrylic Polyurethane finish paint	Chlorinated rubber based finish paint	Epoxy-High Build coating	Solvent less epoxy coating	High build coal tar epoxy coating.
2	Type and composition	Two-pack aliphatic isocyanate cured acrylic finish paint.	Single pack plasticised chlorinated rubber based medium with chemical and weather resistant pigments.	F-6A Two-pack Aromatic amine cured epoxy resin medium suitably pigmented. F-6B: polyamide cured epoxy resin medium suitably pigmented	Two pack, cured with Amine Adduct; catalyzed epoxy resin suitably pigmented	Two pack polyamide cured epoxy resin blended with coaltar medium, suitably pigmented
3	Volume Solids %	40 ± 3	38±2	60±3	99±1	65±3
4	DFT (Dry Film thickness) per coat in microns	30-40μ	30-40	100-125μ	200-500	100-125μ
5	Theoretical covering capacity in M <sup>2</sup> /coat/litre	11-15	11-15	5-6	2-3	5.2-6.5
6	Weight per liter in kgs/litre	1.15±0.03	1.15±0.03	1.42±0.03	1.40±0.03	1.40±0.03
7	Touch dry at 30°C	30 minutes	30 minutes.	3 hrs.	3 hrs.	4 hrs.
8	Hard dry at 30°C (max) Full cure at 30°C (for immersion/ high temperature service)	8 hrs	8 hrs	16 hrs 5 days	16 hrs	48 hrs 5 days
9	Over-coating interval at 30°C	Min.12 hrs.	Min.: Overnight	Min.: Overnight Max.: 5 days	Min.: 8 hrs. Max.: 48 hrs.	Min.: 24 hrs Max.: 5 days.
10	Pot life (approx.) at 30°C for two component paints	6-8 hrs.	Not applicable	4-6 hrs	30 minutes	4-6 hrs.
11	Temperature Resistance (minimum)	80°C Dry service min	60°C Immersion service	80°C Dry service	120°C(Dry service), 50°C (Immersion service)	125°C Immersion service

## PAINT MATERIALS

### TABLE No. 6.3 FINISH PAINTS

Sl. No	DESCRIPTION	F-8	F-9	F-11	F-12
1	Technical name	Self priming type surface tolerant high build epoxy coating (complete rust control coating).	Inorganic zinc silicate coating	Heat resistant synthetic medium based two pack Aluminium paint suitable up to 250°C dry temp.	Heat resistant silicone Aluminium paint suitable up to 500°C dry temp.
2	Type & composition	Two pack epoxy resin based suitable pigmented and capable of adhering to manually prepared surface and old coating.	A two pack air drying self curing solvent based inorganic zinc silicate coating with minimum 80% zinc content on dry film. The final cure of the dry film shall pass the MEK rub test.	Heat resistant synthetic medium based two pack Aluminium paint suitable up to 250°C.	Single pack silicone resin based medium with Aluminium flakes.
3	Volume Solids %	78±3	60±3	38±0.03	20±2
4	DFT (Dry Film thickness) per coat in microns	100-125	65-75µ	15-20µ	15-20µ
5	Theoretical covering capacity in M <sup>2</sup> /coat/litre	6.0-7.2	8-9	10-12	8-10
6	Weight per liter in kgs/litre	1.41±0.03	2.3±0.03	0.95±0.03	1.00±0.03
7	Touch dry at 30°C (maximum)	3 hrs.	30 minutes.	3 hrs.	30 minutes.
8	Hard dry at 30°C (maximum)	24 hrs	12	12 hrs	24 hrs
	Full cure 30°C (for immersion /high temperature service)	5days	NA	NA	NA
9	Over-coating interval	Min.: 10 hrs	Min.: 12 hrs .at 20°C & 50 % RH	Min. 24 hrs	Min.: 24 hrs
10	Pot life at 30°C for two component paints	90 minutes.	4-6 hrs.	Not applicable	Not applicable
11	Temperature Resistance (minimum)	80 °C Dry service	400 °C Dry service	250°C Dry service	500°C Dry service

# PAINT MATERIALS

## TABLE No. 6.4 FINISH PAINTS

Sl. No	DESCRIPTION	F-14	F-15	F-16	F-17
1	Technical name	Polyamine cured coal tar epoxy	Two-component Epoxy phenolic coating cured with Polyamine adduct hardener system (primer + intermediate coat + finish paint)	Ambient temperature curing Poly Siloxane coating/High build cold applied inorganic copolymer based aluminium coating suitable for under insulation coating of CS and SS piping for high temperature service.	Two component solvent free type high build epoxy phenolic/novalac epoxy phenolic coating cured with Polyamine adduct hardener system
2	Type & composition	Specially formulated polyamine cured coal tar epoxy suitable for application under insulation	Two pack ambient temperature curing epoxy phenolic coating system suitable for application under insulation of CS/SS piping	Suitable for high temperature service and under insulation coating for CS, alloy steel and SS	Two component solvent free type high build epoxy phenolic/novalac epoxy phenolic coating cured with Polyamine adduct hardener system
3	Volume Solids %	70±3	70±3	60±2	98-100
4	DFT (Dry Film thickness) per coat in microns	100-125	75-100	75-100	125- 150
5	Theoretical covering capacity in M <sup>2</sup> /coat/ litre	5-8	4-5	7.0- 9.0	6.5 - 8
6	Weight per liter in kgs/litre (mix paint)	1.45±0.03	1.65±0.03	1.3	1.7
7	Touch dry at 30°C (maximum)	4 hrs	3 hrs	1 hr	2 hrs
8	Hard dry at 30°C (maximum) Full cure 30°C (for immersion /high temp. service)	24 hrs 168 hrs (7 days)	24 hrs 168 hrs (7 days)	16 hrs -	24 hrs 168 hrs (7 days)
9	Over-coating interval	Min. 6 hrs Max.5 days	Min. 36 hrs Max.21 days	Min.16 hrs Max. Not applicable	Min. 16 hrs Max.21 days
10	Pot life at 30°C for two component paints	4 hrs	4-6 hrs	1 hr	1 hr
11	Temperature Resistance	-45°C to 125°C under insulation And immersion	-45°C to 150°C under insulation & immersion	Up to 600 <sup>0</sup> C (Note: 5)	-45°C to 150°C for immersion service

### NOTES (for tables 6.1 to 6.4):

1 Covering capacity and DFT depends on method of application. Covering capacity specified above are theoretical. Allowing the losses during application, min specified DFT should be maintained.

2. All primers and finish coats should be cold cured and air drying unless otherwise specified.
- 3 All paints shall be applied in accordance with manufacturer's instructions for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship should be ensured. In case of conflict between this specification and manufacturer's recommendation, the same shall be clarified.
- 4 Technical data sheets for all paints shall be supplied at the time of submission of quotations.
- 5 F-16: Ambient temperature curing poly siloxane Coating or high build cold applied inorganic co-polymer based aluminium coating. Inert polymeric matrix paint product with applicable temperature range of -180 to 650deg C is also comes under this category

## **7.0 COATING SYSTEMS SELECTION CRITERIA**

The coating system (External) should be selected based on the Plant location as given below:

### Classification based on Plant Location:

- a) Plant located in Inland area (more than 50 km from coast)  
Environment Classification – *Industrial*
  - For offsite areas : Table 9.0 to be followed
  - For all UNITS, DM, CPP & Cooling Tower etc: Table 10.0 to be followed
- b) Plant located on sea coast or within 50 km from sea coast;  
Environment classification- *Industrial marine*
  - For offsite area, UNITS, DM, CPP & Cooling Tower etc.: Table 10.0 to be followed
- c) For external surface of above ground tanks, table 12.0 to be followed for all locations (Inland or coastal)

### Notes:

1. Coating systems (Primers, Finish Paints etc.) based on Area classification/environments/Applications are tabulated in Table 8.0 to Table 17.0
2. Primers & Finish paints covered in Tables 8.0 to 17.0 are listed in Table 7.1.
3. Repair of Pre-Erection/Pre-Fabrication & Shop priming after erection/ welding shall be done as per Table 7.2.

**TABLE 7.1: LIST OF PRIMERS & FINISH COATS COVERED IN TABLE NOS. 8 to 18.0**

<b><u>PRIMERS</u></b>	
P-2	Chlorinated rubber zinc Phosphate Primer
P-4	Etch Primer/Wash Primer
P-6	Two component Epoxy Zinc Phosphate Primer cured with polyamine hardener
P-7	Single pack, cold galvanizing compounds containing minimum 92% electrolytic zinc in dry film. make ZINGA, LOCKTITE (of HENKEL) or ZRC
F-9	Two component Inorganic Zinc Silicate coating
<b><u>FINISH COATS / PAINTS</u></b>	
F-2	Two component Acrylic – Polyurethane finish paint
F-3	Chlorinated Rubber finish paint
F-6A	High Build Epoxy finish coating cured with polyamine hardener
F-6B	High Build Epoxy finish coating cured with polyamide hardener
F-6C	Solvent less Epoxy Coating cured with poly amine hardener
F-7	High build Coal Tar epoxy coating cured with polyamine hardener
F-8	Self priming surface Tolerant High Build epoxy coating. cured with polyamine hardener
F-11	Heat resistant synthetic medium based Aluminium paint
F-12	Two component Heat resistant Silicone Aluminium paint.
F-14	Specially formulated coal tar epoxy coating. cured with polyamine hardener
F-15	Two component Epoxy phenolic coating cured with Polyamine adduct hardener system
F-16	Engineered Epoxy poly Siloxane Coating or high build cold applied inorganic co-polymer based aluminium coating
F-17	Two component solvent free type high build epoxy phenolic/Novalac epoxy phenolic coating cured with Polyamine adduct hardener system

**TABLE 7.2 REPAIR OF PRE-ERECTION/PRE-FABRICATION OR SHOP PRIMER AFTER ERECTION/WELDING**

For all un-insulated CS, LTCS &amp; alloy steel items in all Environments

Sl. No.	Design Temp. in °C	Surface Preparation	Coating System	Total DFT in Microns (min.)	Remarks
7.2.1	-90 to 400	SSPC-SP-3	1 coat of F-9	65-75	See note below and clause 5.9.3
7.2.2	401 to 550	SSPC-SP-3	1 coat of F-12	20	

**NOTES:**

- The application and repair of pre-erection/pre-fabrication or Shop Primer given in above tables shall be done for all the items to be painted. In case the damages of primer are severe and spread over large area, entire primer shall be removed by blasting to achieve SSPC-SP-10 and surfaces to be primed again with F-9 or F-12 as applicable.

**TABLE 8.0 COATING SYSTEM FOR GI HAND RAILS & GI ITEMS WHICH REQUIRE COLOUR CODING- All locations**

Sl. No.	Design Temp. in °C	Coating System	Total DFT in Microns (min.)
8.1	Up to 60	Hot Dip Galvanizing <sup>5</sup> to 80-85 microns (600-610 gm/m <sup>2</sup> ) as per IS 4759, 2629, 4736, 2633 + 1 coat of P-6 <sup>5</sup> @ 40µ DFT/coat + 1 coat of F-2 @ 40 microns DFT/coat	80 microns of finish coat (excluding the thickness of galvanizing )

**NOTES:**

- Galvanization thickness mentioned here is indicative. However Galvanization of respective items shall be as per applicable Standards/Job specifications attached elsewhere in the contract.
- Repair of the damaged area of galvanized coatings due to welding during erection shall be carried out as per recommended practice IS 11759 using cold galvanizing spray process. Organic Paint systems are not acceptable for repair.
- After repair of damaged galvanized coating by Cold Galvanized, the repaired area shall be top coated with paint system as given in Table 8.0 above (i.e., 1 coat of P-6 @ 40µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat).
- Suggested Cold Galvanizing manufacturers are **ZINGA, LOCKTITE** or **Z.R.C.**
- Before painting is applied, solvent cleaning in accordance with SSPC-SP-1 shall be carried out. Contractor shall consider for applying etch primer (P-4) or equivalent on cleaned GI surfaces after consultation with paint supplier.

**TABLE 9.0 COATING SYSTEM FOR OFFSITE AREA (INLAND PLANTS)**

For external surfaces of Un-insulated & aboveground (atmospheric exposure) Structures, Piping, Vessels, Equipments, Pumps, etc. (Note-1); (For Carbon Steel, LTCS & Alloy Steel).

See Note Below\*

Sl. No.	Design Temp. °C	Surface Preparation & Pre-erection/Shop Primer	Coating System (Post-erection / Field)		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
9.1	-90 to -15	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	None	None	65-75	No over-coating over F-9 is allowed    F-12 shall be ambient temperature curing type
9.2	-16 to 80	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	1 coat of P-6 @40 µ	1 coat of F-6B @ 100 µ + 1 coat of F-2 @ 40µ DFT/coat	245-255	
9.3	81 to 250	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	None	2 coats of F-11 @ 20µ DFT/coat; (2x20=40)	105-115	
9.4	251 to 400	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	None	2 coats of F-12 @ 20µ DFT/coat (2x20=40)	105-115	
9.5	401 to 550	SSPC-SP-10; 1coat of F-12 @ 20-25µ DFT/coat	None	2 coats of F-12 @20-25µ DFT/coat (2x20=40)	60-75	

\* Flare line within unit or offsite areas shall be coated as per Clause 10.3 of Table 10.0, having finish coat of 2 coats of F-12.

**NOTES:**

- The list of items given in the heading of the above table is not exhaustive. There may be more items for a particular contract where these specifications are used. The Contractor is fully responsible for completing painting including prefabrication primer for all the items supplied and fabricated through his scope of work as per tender document.
- If the Pre-erection/Pre-fabrication & Shop Primer has already been completed, the same shall not be repeated again in the field. In case the damages of primer are severe and spread over large areas, the engineer-in-charge may decide & advise re-blasting and priming again. Repair of pre-fabrication/pre-erection primer, if required, shall be done as per Table 7.2.
- In case of Paint systems as per Sl. Nos. 9.5 and 9.6, the color bands shall be applied over the Aluminum paint as per the Color coding requirement for specific service of piping given in Clause 19.0.
- All coating system including surface preparation, primer, and finish coat for piping shall be done at field only.

**TABLE 10.0 COATING SYSTEMS FOR UNIT AREAS AS WELL AS DM, CPP, COOLING TOWER OF INLAND PLANTS AND FOR ALL AREAS (UNIT, OFFSITE, DM, CPP, etc.) OF COASTAL PLANTS**

For external surfaces of un-insulated and above ground (atmospheric exposure) structures, piping, vessels, equipments, external surface of MS chimney/stacks, RCC chimney, internal surface of MS chimney without refractory lining, towers, columns, pumps, compressors, blowers etc. of carbon steel, LTCS & alloy steels (note-1)

Sl. No.	Design Temp. in °C	Surface Preparation & Pre-erection/Shop Primer	Coating System (Post-erection / Field)		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
10.1	-90 to -15	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	None	None	65-75	<p>a) No over-coating to be done on F-9 as it will lead to mud cracking.</p> <p>b) F-12 shall be ambient temperature curing type</p> <p>c) Finish coat including primer compatible with finish coat (i.e. field primer) shall be applied at site only. Finish coating is not permitted at equipment manufacture shop.</p>
10.2	-14 to 80	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	1 coat of P-6 @ 40 µ DFT/coat	2 coats of F-6B @ 100 µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat; (2x100 + 40= 240)	345-355	
10.3	81 to 400	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	None	2 coats of F-12 @ 20µ DFT/coat 2x20=40	105-115	
10.4	401 to 550	SSPC-SP-10; 1coat of F-12 @ 20µ DFT/coat	None	2 coats of F-12 @ 20µ DFT/coat; (2x20=40)	60	

**NOTES:**

- The list of items given in the heading of the above table is not exhaustive. There may be more items for a particular contract where these specifications are used. The Contractor is fully responsible for completing painting including prefabrication primer for all the items supplied and fabricated through his scope of work as per tender document.
- If the Pre-erection/Pre-fabrication & Shop Primer has already been completed, the same shall not be repeated again in the field. In case the damages of primer are severe and spread over large areas, the engineer-in-charge may decide & advise re-blasting and priming again. Repair of pre-fabrication/pre-erection primer, if required, shall be done as per Table 7.2.



3. For external surface of MS chimney with or without refractory lining and for internal surface without refractory lining, paint system as per 10.3 above shall be followed.
4. For external surface of RCC Chimney, 2 coats of F-6B @ 100 $\mu$  DFT/coat to obtain total DFT of 200  $\mu$  shall be applied after proper surface preparation as per guidelines in 5.1.6.
5. In case of paint systems as per Sl. Nos. 10.3 and 10.4, the colour bands shall be applied over the Aluminum paint as per the Color coding requirement for specific service of piping given in Clause 19.0.
6. All coating system including surface preparation, primer, finish coat for piping shall be done at site/field only.

**TABLE 11.0 COATING SYSTEMS FOR EFFLUENT TREATMENT PLANT (ETP)**

Sl. No.	Design Temp. in °C	Surface Preparation	Coating System		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
<b>11.1</b>	For External Surfaces of C.S./M.S. items: Screens, Walk way bridges, Baffles, Dual media filters, Vertical pumps, piping in treated effluent sump, bio sludge pump, Screw pump and pump house, CS tanks, sumps and vessels.					
	-14 to 80	SSPS-SP-10	1 coat of F-9 @ 65-75µ DFT/coat	2 coats of F-6A @100µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat; (2x100+40=240)	305-315	-
<b>11.2</b>	For Internal Surfaces of CS/MS Items: Bio-sludge sump, Filter feed sump, Process sump, Sanitary sump, Transfer sump, Sludge, Slop oil tank, scrapping mechanism in Clarifier					
	-14 to 80	SSPS-SP-10	1 coat of F-9 @ 65-75µ DFT/coat.	3 coats of F-6A @100µ DFT/coat (3x100=300)	365-375	Note:1
<b>11.3</b>	All R.C.C./concrete surfaces exposed to effluent water / liquid such as tanks, structures, drains etc. in Process sump, TPI separator (Process and Oil), Aeration Tank and Transfer sump etc.					
	-14 to 80	Blast cleaning to SSPC-SP guide lines and Acid etching with 10-15% HCl acid followed by thorough water washing.	Epoxy Screed lining		3mm	Epoxy screed lining shall be applied as per specific manufacturer and Engineer-in-Charge instructions
<b>11.4</b>	C.S/M.S Dual media filters (Internal), Chemical dosing tanks(internal) such as Di-Ammonium Phosphate (DAP) and Urea					
<b>11.4.1</b>	Up to 60	SSPC-SP-10	1 Coat of clear two component solvent free vinyl ester primer @ 100 microns DFT/ Coat + 2 Coats of two component glass flake filled vinyl ester lining@ 500 microns DFT/ Coat		1100	--

**NOTES**

1. The paint /coating manufacturers shall provide their Quality control test certificate of coating materials (F-6A) for immersion service of the exposed effluent given in 11.2.

**TABLE 12.0 EXTERNAL COATING SYSTEMS FOR UNINSULATED CARBON STEEL AND ALLOY STEEL STORAGE TANKS (For all plant locations, coastal or inland)**

**All Process Units & Off-sites**

Sl. No.	Design Temp. in °C	Surface Preparation (Field)	Coating system (Field) (see note 1 below)		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
<b>12.1</b>	All external surfaces of shell, wind girders, appurtenances, roof tops of all above ground tank including top side of external and internal floating roof and associated external structural works.					
12.1.1	-14 to 80	SSPC-SP-10	1coat of F-9 @ 65-75µ DFT/coat + 1coat of P-6 @ 40µ DFT/ coat ;	2 coats of F-6B @ 100µ DFT /coat + 1 coat of F-2 @ 40µ DFT/ coat;	345-355	F-6 should be suitable for occasional water immersion
12.1.2	81 to 150	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat + 1 coat of F-15 intermediate coat @ 80µ DFT/coat ;	1 coat of F-15 finish coat @80µ DFT/ coat + 1coat of F-2 @ 40µ DFT/ coat;	280	-
12.1.3	151 to 500	SSPC-SP-10	1coat of F-9@ 65-75µ DFT/coat	2 coats of F-12 @20 µ DFT/ coat Or 1 coat of F-16 @ 50 µ DFT / coat	105 or 115	-
<b>12.2</b>	External surfaces of bottom plate (soil side) for all storage tanks.					
12.2.1	-14 to 80	SSPC-SP-10	1 coat of F-9 @ 65-75µ DFT/ coat	3 coats of F-7@ 100µ DFT/coat (3x100=300)	365-375	F-7 should be suitable for immersion service of the products given
12.2.2	81 to 150	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat + 1 coat of F-15 intermediate coat @ 80µ DFT/coat ; (80+80=160)	1 coat of F-15 finish coat @ 80µ DFT/ coat	240	-
12.2.3	151 to 550	SSPC-SP-10	1 coat of F-16 @ 125 µ DFT /coat	1 coat of F-16 @ 125 µ DFT /coat	250	-
<b>12.3</b>	For underside of the bottom plate (in case tank is not lifted during PWHT) (see Note 2c)					

12.3.1	-180 to 650	For CS SSPC SP-6 Commercial Blast	1 coat of inert polymeric matrix coating @ 125 μ	2 coats of inert polymeric matrix coating @ 125 μ	350-400	Products from JOTUN or HI-TEMP coatings or SK FORMULA TIONS are recommen ded.
		For SS SSPC SP-1 with non- chloride solvent				

## NOTES

1. All paint coating application including primer for tankage shall be carried out at field after erection and completion of all welding.
2. For underside of bottom plate :
  - a) Painting shall be carried out before laying of bottom plate for tanks with Non-Post Weld Heat Treatment (PWHT).
  - b) For tanks with PWHT, painting shall be carried out after PWHT.
  - c) In case tank is not lifted during PWHT then painting shall be applied before laying of bottom plate, clause no. 12.3.1 shall be followed.

**Caution:** PWHT temperature shall not exceed 650°C.

**TABLE 13.0 INTERNAL COATING SYSTEMS FOR CARBON STEEL AND ALLOY STORAGE TANKS & VESSELS**

**All Process Units & Off-sites**

Sl. No.	Design Temp. in °C	Surface Preparation (Field)	Coating system (Field) (see note 1 below)		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
<b>13.1</b>	<b>CRUDE OIL, ATF, TURPENTINE OIL &amp; LUBRICATING OIL</b> Underside of floating roof, internal surface of cone roof, inside of bottom plate, Internal surfaces of Shell - including wetted and free board height, oil side surfaces of deck plates, oil side surfaces of pontoons, roof structures, structural steel, ladders and other CS internals					
13.1.1	-14 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat;	240-300	-
<b>13.2</b>	<b>PETROLEUM PRODUCTS &amp; INTERMEDIATES like LDO, HSD , GAS OIL, FEEDS of FCC-PC, FCC-LCO, VGO-HDT, ISOM, DHDT, REFORMATE, DCU, NHT &amp; GASOLINE, NAPHTHA, ISOMERATE AND KEROSENE.</b> Underside of Floating roofs, internal surface of cone roof, inside of bottom plate, internal surfaces of Bare shell for full height, underside of floating roof, oil side surfaces of deck plates, oil side surfaces of pontoons, support structures and ladders etc.					
13.2.1	-14 to 45	SSPC-SP-10	1 coat of F-9 @ 75 µ DFT/coat	-	75	Note 2
13.2.2	46 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat;	240-300	-
<b>13.3</b>	<b>POTABLE, SERVICE AND FIRE WATER</b> All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
13.3.1	-14 to 60	SSPC-SP-10	1 Coats of P-6 @ 100 µ DFT/coat;	2 Coats of F-6A @ 100µ DFT/ Coat; (2x100=200)	300-350	Note-4
<b>13.4</b>	<b>DM WATER &amp; CONDENSATES</b> All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
13.4.1	-14 to 60	SSPC-SP-10	1 Coats of P-6 @ 100µ DFT/coat;	2 coats of F-6C @ 200µ DFT/ coat; (2x200=400)	500-550	-
13.4.2	61 to150	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat; (80+80=160)	240-300	-

13.5	<b>HYDROCHLORIC ACID (HCl) 10 %</b> All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
13.5.1	-14 to 60	SSPC-SP-10	1 Coat of clear two component solvent free vinyl ester primer @ 100 microns DFT/ Coat	2 Coats of two component glass flake filled vinyl ester lining@ 500 microns DFT/ Coat	1100	-
13.6	<b>AGGRESSIVE SOLVENTS LIKE HEXANE, HEXENE, BENZENE, XYLENE AND TOLUENE</b> All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
13.6.1	-14 to 65	SSPC-SP-10	1 coat of F-9 @ 75µ DFT/ coat	---	75	-
13.7	<b>ETHYLENE GLYCOL (EG) TANKS</b> Internal shell-full height, bottom plate, underside of roof and all accessories					
13.7.1	All	SSPC-SP-10	None	3 coats of vinyl chloride co-polymer AMERCOAT 23 @ 75µ /Coat; (3x75=225)	225	-
13.8	<b>Inside pontoon and inside of double deck of all floating roofs</b>					
13.8.1	-14 to 80	SSPC-SP-3	1 coat of F-8 @ 100µ DFT/coat	1 coat of F-8 @ 100µ DFT/coat	200	-
13.9	<b>WET SLOPS, AMINE solutions, SOUR WATER , WATER DRAW OFF</b> All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
13.9.1	-14 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/ coat; (80+80=160)	240	-
13.10	<b>VACUUM RESIDUE, FUEL OIL , DRY SLOP, BITUMEN AND OTHER HIGH TEMPERATURE HYDROCARBON LIQUIDS</b> Underside of floating roof, internal surface of cone roof, bottom plate, inside of bare shell – including wetted and non wetted surfaces, oil side surfaces of deck plates, oil side surfaces of pontoons, roof structures, structural steel and ladders					
13.10.1	Up to 150°C	SSPC-SP-10	1 coat of F-17 primer @ 125µ DFT/ coat	1 coat of F-17 intermediate coat @ 125µ DFT/coat + 1 coat of F-17 finish coat @125µ DFT/ coat; (125+125=250)	375	Note:3
13.11	<b>ALKALIS UP TO 50 % CONCENTRATION</b> All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
13.11.1	Up to 60°C	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat	2 Coats of F-6 A @ 100µ DFT/coat; (2x100=200)	280-100	-

## NOTES

- All paint coating application including primer shall be carried out after erection and completion of all welding work at site.

2. F-6A should be suitable and resistant for immersion service for the respective Hydrocarbons.
3. This system can be used where maximum operating temperature is below 150°C and design temperature is up to 200°C. Cases of operating temperature > 150°C are not covered in this spec, such cases shall be covered in separate job specifications -as required.
4. F-6 A shall be suitable for *drinking water service* and should have competent authority certification.

**TABLE 14.0 COATING SYSTEMS FOR EXTERNAL SIDE OF UNDERGROUND CARBON STEEL PLANT PIPING AND UNDERGROUND VESSELS**

Sl. No.	Design Temp. in °C	Surface Preparation & Shop Primer	Coating system (Field) <sup>1</sup>		Total Final DFT in Microns (min.)	Remarks
			Surface Preparation & Primer	Finish Coat		
<b>14.1</b>	<b>Underground carbon steel plant piping</b>					
14.1.1	25 to 65	---	SSPC-SP-10; 1 coat of synthetic fast drying primer 25 @µ DFT/ coat	1 layer of coal tar tape coating @ 2mm + 1 coat of synthetic fast drying primer 25 @µ DFT/ coat + 1 layer of coal tar tape coating @ 2mm /layer as per Standard Specification	4 mm	The primer DFT is not measurable. Reconciliation primer shall be done by coverage of maximum 10 sq.m/litre
14.2.1	66 to 150	---	SSPC-SP-10; 1 coat of F-17 primer @ 125µ DFT/ coat	1 coat of F-17 intermediate coat @ 125µ DFT/coat + 1 coat of F-17 finish coat @ 125µ DFT/ coat	375	-
14.2.2	151 to 400	---	SSPC-SP-10; 1 coat of F-16 primer @ 125µ DFT/ coat	1 coat of F-16 finish coat @ 125µ DFT/ coat	250	-
<b>14.3</b>	<b>External side of un-insulated underground vessels</b>					
14.3.1	-40 to 80	SSPC-SP-10; 1 coat of F-9 @ 65-75µ DFT/ coat	---	3 coats of F-7 @ 100µ DFT/coat	365-375	-
14.3.2	81 to 150	SSPC-SP-10; 1 coat of F-17 primer @ 125µ DFT/ coat	---	1 coat of F-17 intermediate coat @ 125µ DFT/coat + 1 coat of F-17 finish coat @ 125µ DFT/ coat	375	-
14.3.3	151 to 400	SSPC-SP-10; 1 coat of F-16 primer @ 125µ DFT/ coat	---	1 coat of F-16 finish coat @ 125µ DFT/ coat	250	-

1. Shop & Field priming mentioned here is indicative only and shall be in accordance with applicable SOR/MR/PRs.



**TABLE 15.0****COATING SYSTEMS FOR UNDER INSULATION (COASTAL OR INLAND PLANTS)**

ALL UNIT AREAS &amp; OFF-SITES

For insulated Piping, Equipments, Storage vessels, tanks, Columns etc of Carbon Steel, LTCS, Alloy Steel &amp; Stainless Steels

Sl. No.	Design Temp. in °C	Surface Preparation & Pre-erection/Shop Primer <sup>3</sup>	Paint system (Field) <sup>3</sup>		Total Final DFT in Microns (min.)
			Primer	Finish paint	
<b>15.1</b>	<b>Carbon steel, LTCS and alloy steel Piping, Storage tanks, vessels, equipments etc</b>				
15.1.1	-45 to 125	SSPC-SP-10; 1coat of F-9 @ 75µ DFT/coat	None	3 coats of F-15 @ 75µ DFT/coat	305- 315
15.1.2	126 to 400	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat for up to 400 °C	None	3 coats of F-12 @ 20µ DFT/coat	125-135
		1 coat of F-12 @20µ DFT/coat for 400-450 °C			80-100
<b>15.2</b>	<b>Stainless Steel, Alloy Steel, Alloy-20 Piping, Vessels &amp; Equipments</b>				
15.2.1	-45 to 125	Sweep blasting/Light Blast clean as per grade Sa-1.0, of Swedish Standards SIS-05-5900 (Latest) (15-25µ surface profile) 1 coat of F-15@ 80 µ DFT/coat	None	1 coat of F-15 intermediate coat @ 80µ DFT/coat + 1 coat of F-15 finish coat @ 80µ DFT/coat; (80+80=160)	240
15.2.2	126 to 550	1 coat of F-16@ 125µ DFT/coat	None	1 coat of F-16@ 125µ DFT/coat	250
<b>15.3</b>	<b>Cyclic service of CS, LTCS, SS, &amp; Alloy Steels</b>				
15.3.1	-180 to 650 (Note:2)	SSPC-SP-10 Inert polymeric matrix coating* @ 125µ DFT/coat for SS sweep blasting/Light Blast clean as per grade Sa-1.0, of Swedish Standards SIS-05-5900 (Latest) (15-25µ surface profile)	none	2 coats of Inert polymer matrix coating* @ 125µ DFT/coat (Note:4)	250

**NOTES**

\* Alternatively Thermally Sprayed Aluminium (TSA) @500 µ is acceptable.  
AMERCOAT 738/JOTATEMP-650 or equivalent is acceptable.

1. The blast cleaning abrasives for SS and Alloy steel surfaces shall be SS grits/shots or Aluminium oxide grits/shots.
2. For piping with cyclic temperature of -45 to 125 deg.C Sr.No 15.2.1 is applicable.
3. Shop & Field priming mentioned here is indicative only and shall be in accordance with applicable SOR/MR/PRs.
4. This coating system is also applicable for any other services of these metallurgies in the temperature range -180 to 650 which are not covered in 15.1 & 15.2.

**TABLE 16.0 COATING SYSTEM FOR CARBON STEEL COMPONENTS OF COOLERS / CONDENSERS (INTERNAL PROTECTION) FOR FRESH WATER SERVICE**

Fresh Water boxes, channels, partition plates, end covers and tube sheets etc.

Sl. No.	Design Temp. in °C	Surface Preparation & Pre-erection/Shop Primer	Coating System (Post-erection / Field)		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
16.1	Up to 80 °C	SSPC-SP-10	1 coat of F-15 @ 80 microns	2 coats of F-15 @ 80µ DFT/coat;	240	-
16.2	80 to 140	SSPC-SP-10	---	1 coat of Glass Fibre Reinforced Novolac epoxy of 1.5 mm DFT	1500	-

**TABLE 17.0 COATING SYSTEM (INTERNAL PROTECTION) FOR GALVANIZED OR NON FERROUS OR STAINLESS STEEL/ DUPLEX STAINLESS STEEL COMPONENTS OF COOLERS/ CONDENSERS FOR FRESH WATER SERVICE**

Sl. No.	Design Temp. in °C	Surface Preparation & Pre-erection/Shop Primer	Coating System (Post-erection / Field)		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
17.1	Up to 80	Sweep Blasting	1 coat of F-15 @ 80µ DFT/coat;	1 coat of F-15 @ 80µ DFT/coat;	160	-
17.2	80 to 140	Sweep Blasting	---	1 coat of Glass Fibre Reinforced Novolac epoxy of 1.5 mm DFT	1500	-

**18.0 STORAGE**

**18.1** All paints and painting materials shall be stored only in rooms to be arranged by contractor and approved by Engineer-in-charge for the purpose. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separate from adjacent building. A signboard bearing the word “PAINT STORAGE – NO NAKED LIGHT – HIGHLY INFLAMABLE” shall be clearly displayed outside. Manufacturer’s recommendation shall be followed for storage of paint materials.

**19.0 PAINT COLOUR CODE FOR PIPING AND EQUIPMENT**

Unless otherwise specified, the following shall be followed:

**19.1 IDENTIFICATION**

The system of colour coding consists of a ground colour and secondary colour bands superimposed over the ground colour. The ground colour identifies the basic nature of the service and secondary colour band over the ground colour distinguishes the particular service. The ground colour shall be applied over the entire length of the un-insulated pipes. For insulated lines ground colour shall be provided as per specified length and interval to identify

the basic nature of service and secondary colour bands to be painted on these specified length to identify the particular service. Above colour code is applicable for both unit and offsite pipelines.

The following ground colour designation for identification of basis classification of various important services shall be followed.

Post Office Red	Fire protection materials
Off White / Aluminium	Steam (all pressures)
Canary Yellow	Chemicals and dangerous materials
Dark Admiralty Grey	lube oil
Orange	Volatile petroleum products (motor sprit and lighter)
Oxide red	Non-Volatile petroleum products (kerosene and heavier, including waxy distillates and diesel, gas oil)
Black	Residual oils, still bottoms, slop oils and asphalts, fuel oil
Sky blue	Water (all purities and temperatures)
Sea green	Air and its components and Freon

19.1.1 Secondary colours: The narrow bands presenting the secondary colour which identifies the specific service may be applied by painting or preferably by use of adhesive plastic tapes of the specific colour.

## 19.2 COLOUR BANDS AND IDENTIFICATION LETTERING

19.2.1 The following specifications of colour bands shall be followed for identifying the piping contents, size and location of bands & letters. The bandwidth and size of letters in legends will depend to some extent upon the pipe diameter. Either white or black letters are selected to provide maximum contrast to the band colour. Bands usually are 100 mm wide and regardless of band width, are spaced 50 mm apart when two bands are employed.

Colour bands and size of lettering for piping:

Outside diameter of pipe or covering in mm	Width of colour bands in mm	Size of legend Letters in mm
19 to 32	200	13
38 to 51	200	19
64 to 150	300	32
200 to 250	600	64
Over 250	800	89

In addition, ground colour as per specified length should be provided on insulated piping for easy identification of nature of fluid, on which the colour bands should be painted for identification of each service. The length of the ground colour should be 3 times the width of normal bands or 2 meters, whichever is suitable depending on the length of the pipe.

Size of letters stenciled/ written for equipment shall be as given below:

Column and vessel	:	150 mm (Height)
Pump, compressor and other machinery	:	50 mm (Height)

In addition, the contents of the pipe and/or direction of flow may be further indicated by arrows and legend. If a hazard is involved it must be identified clearly by legend.

- 19.2.2 Colour bands: The location and size of bands, as recommended, when used, shall be applied to the pipe.
- On both sides of the valves, tees and other fittings of importance.
  - Where the pipe enters and emerges from walls and where it emerges from road & walkway overpasses, unit battery limits.
  - At uniform intervals along long sections of the pipe.
  - Adjacent to tanks, vessels, and pumps.
- 19.2.3 For piping, writing of name of service and direction of flow for all the lines shall be done at following locations:
- 19.2.3.1 Offsite Lines: Both sides of culverts, any one side of walkways, near tank dykes, at tank inlet/outlet points and suction/ discharge of pumps/ compressors.
- 19.2.3.2 Unit Lines: At the battery limit, suction/ discharge of pumps/ compressors, near vessels, columns, Tanks, Exchangers etc.
- 19.2.4 The letters will be in black on pipes painted with light shade colours and white on pipes painted with dark shade colours to give good contrast.
- 19.2.5 Only writing of service name shall be done on stainless steel lines. Precautions should be taken while painting by using low chloride content painting to avoid any damage to the stainless steel pipes. It is preferable to use adhesive plastic tapes to protect stainless steel pipes.
- 19.2.6 Colour band specification:
- a) Unit Area: Bands at intervals of 6.0 meters.  
Offsite Area: Bands at intervals of 10.0 meters.
  - b) Each pipe segment will have minimum one band indication, irrespective of length.
  - c) The bands shall also be displayed near walkways, both sides of culverts, tanks dykes, tanks, vessels, suction and discharge of pumps/ compressors, unit battery limit, near valves of line, etc.
- 19.3 For alloy steel/ stainless steel pipes and fittings in stores/ fabrication yard, color band (Minimum ½” wide) should be applied along the complete length of pipe, bends/ tees, side-curved surface (on thickness) of flanges as well as valves as per the metallurgy.
- 19.4 In case of camouflaging requirements of civil defence or any other locational requirements, the same shall be followed accordingly.
- 19.5 The specification for application of the complete Piping identification colour code, including base and bands colours, are presented in the enclosed table.

## 20.0 RECOMMENDED COLOUR CODE

Unless otherwise specified and/or specific requirement of the OWNER, following colour coding may be followed:

SR. No.	SERVICE	RECOMMENDED COLOUR FOR PAINT SYSTEM	RAL COLOUR CODE	
			BASE COLOUR	BAND COLOUR
<b>HYDROCARBON LINES (UNINSULATED)</b>				
1	LUBE OILS	Dark Admiralty grey with 1 green band	7012	6010
2	FLARE LINES	Heat Resistant Aluminium	9006	
3	LPG	Orange with 1 oxide red band	2011	3009
4	PROPYLENE	Orange with 2 blue bands	2011	5013
5	NAPHTHA	Orange with 1 green band	2011	6010
6	M.S.	Orange with 1 dark admiralty grey band	2011	7012
7	N-PENTANE	Orange with 2 blue bands	2011	5013
8	DIESEL OIL (White)	Oxide red with 1 white band	3009	9010
9	DIESEL OIL (Black)	Oxide red with 1 yellow band	3009	1023
10	KEROSENE	Oxide red with 1 green band	3009	6010
11	HY.KEROSENE	Oxide red with 2 green bands	3009	6010
12	DISULFIDE OIL (EX-MEROX)	Oxide red with 1 black band	3009	9005
13	M.T.O	Oxide red with 3 green bands	3009	6010
14	DHPPA	Oxide red with 2 white bands	3009	9010
15	FLUSHING OIL	Oxide red with 2 black bands	3009	9005
16	LAB FS	Oxide red with 2 dark admiralty grey bands	3009	7012
17	LAB RS	Oxide red with 3 dark admiralty grey bands	3009	7012
18	LAB (Off. Spec)	Oxide red with 1 light grey band	3009	7035
19	N-PARAFFIN	Oxide red with 1-blue band	3009	5013
20	HEAVY ALKYLATE	Oxide red with red band	3009	3001
21	BLOW DOWN, VAPOR LINE	Off white / Aluminum with 1-Brown band	9006	8004
22	BLOWDOWN	Off white / Aluminum with 2 brown bands	9006	8004
23	A.T.F.	Leaf brown with 1 white band	8003	9010
24	TOULENE	Leaf brown with 1 yellow band	8003	1023
25	BENZENE	Leaf brown with 1 green band	8003	6010
26	LAB PRODUCT	Leaf brown with 1 blue band	8003	5013
27	FUEL OIL	Black with 1 yellow band	9005	1023
28	FULE OIL (Aromatic rich)	Black with 2 yellow bands	9005	1023
29	ASPHALT	Black with 1 white band	9005	9010
30	SLOP AND WASTE OILS	Black with 1 orange band	9005	2011
31	SLOP AROMATICS	Black with 2 orange bands	9005	2011
<b>CHEMICAL LINES</b>				
32	TRI-SODIUM PHOSPHATE	Canary yellow with 1 violet band	1012	5000
33	CAUSTIC SODA	Canary yellow with 1 black band	1012	9005
35	SODIUM CHLORIDE	Canary yellow with 1 white band	1012	9010

36	AMMONIA	Canary yellow with 1 blue band	1012	5013
36	CORROSION INHIBITOR	Canary yellow with 1 Aluminum band	1012	9006
37	HEXAMETA PHOSPHATE	Canary yellow with 2 black bands	1012	9005
38	ACID LINES	Golden Yellow with 1 red band	1004	3001
39	RICH AMINE	Canary yellow with 2 blue bands	1012	5013
40	LEAN AMINE	Canary yellow with 3 blue bands	1012	5013
41	SOLVENT	Canary yellow with 1 green band	1012	6010
42	LCS	Canary yellow with 1 smoke grey	1012	7031

### WATER LINES

43	RAW WATER	Sky blue with 1 black band	5015	9005
44	INDUSTRIAL WATER	Sky blue with 2 signal red band	5015	3001
44	TREATED WATER	Sky blue with 1 oxide red band	5015	3009
45	DRINKING WATER	Sky blue with 1 green band	5015	6010
46	COOLING WATER	Sky blue with 1 light brown band	5015	1011
47	SERVICE WATER	Sky blue with 1 signal red brown	5015	3001
48	TEMPERED WATER	Sky blue with 2 green bands	5015	6010
49	DM WATER	Sky blue with 1 aluminum band	5015	9006
50	DM WATER ABOVE 150°F	Sky blue with 2 black bands	5015	9005
51	SOUR WATER	Sky blue with 2 yellow bands	5015	1013
52	STRIPPED WATER	Sky blue with 2 blue bands	5015	5013
53	ETP TREATED WATER	Sky blue with 2 oxide red bands	5015	3009

### FIRE PROTECTION SYSTEM (ABOVE GROUND)

54	FIRE WATER FOAM & EXTINGUISHERS	Post office red	3002	
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### AIR & OTHER GAS LINES (UNINSULATED)

55	SERVICE AIR	Sea green with 1 signal red band	6018	3001
56	INSTRUMENT AIR	Sea green with 1 black band	6018	9005
57	NITROGEN	Sea green with 1 orange band	6018	2011
58	FREON	Sea green with 1 yellow band	6018	1023
59	CHLORINE	Canary yellow with 1 oxide band	1012	3009
60	SO <sub>2</sub>	Canary yellow with 2 white bands	1012	9010
61	H <sub>2</sub> S	Orange with 2 red oxide bands	2011	3009
62	GAS (Fuel)	Orange with 1 aluminum band	2011	9006
63	GAS (Sour)	Orange with 2 aluminum bands	2011	9006
64	GAS (Sweet)	Orange with 2 signal red band	2011	3001
65	HYDROGEN	Orange with 1 light green band	2011	6021

### STEAM AND CONDENSATE LINES (UNINSULATED)

66	HP STEAM	Off white / Aluminum with 1 yellow band	9006	1023
67	MP STEAM	Off white / Aluminum with 1 red band	9006	3001
68	MLP STEAM	Off white / Aluminum with 1 orange band	9006	2011

69	LP STEAM	Off white / Aluminum with 1 light green band	9006	6021
70	CONDENSATE	Sky blue with 1 white band	5015	9010
71	CONDENSATE ABOVE 150°F	Sky blue with 3 oxide red band	5015	3009
72	BFW	Sky blue with 2 red bands	5015	3001

Note: For all insulated steam lines, the colour coding shall be follow as given for un-insulated lines with the specified length of color bands.

### INSULATED HYDROCARBON PIPING

### UNINSULATED EQUIPMENTS, TANKS AND STRUCTURES

73	HEATER STRUCTURE	Steel grey	7011
74	HEATER CASING	Heat resistant aluminium	9006
75	VESSELS & COLUMNS	Aluminium	9006
76	HYDROGEN BULLETS	Pink	3014
77	LPG VESSELS	Oxide red	3009
78	SO <sub>2</sub> VESSEL	Canary yellow	1012
79	HEAT EXCHANGER	Heat resistant aluminium	9006
80	FO TANK AND HOT TANKS	Black	9005
81	ALL OTHER TANKS	Aluminum / Off white	9006
82	CAUSTIC / AMINE / ACID TANKS	Golden yellow	1004
83	SOUR WATER	Sky Blue	5015
84	OUTER SURFACE IN BOILER HOUSE	Heat resistant aluminum	9006
85	COMPRESSORS AND BLOWERS	Dark admiralty grey	7012
86	PUMPS	Navy blue	5014
87	MOTORS & SWITCH GEAR	Bluish green	5024
88	HAND RAILING	Signal red	3001
89	STAIRCASE, LADDER AND WALKWAYS	Black	9005
90	LOAD LIFTING EQUIPMENT AND MONORAILS ETC	Leaf brown	8003
91	GENERAL STRUCTURE	Black	9005

### PIPES AND FITTINGS OF ALLOY STEEL AND SS MATERIAL IN STORE

92	IBR	Signal red	3001
93	9Cr-1Mo	Verdigris green	6021
94	5Cr-0.5Mo	Satin blue	5012
95	2 <sub>1/4</sub> Cr-1 Mo	Aircraft yellow	1026
96	1 <sub>1/4</sub> Cr- <sub>1/2</sub> Mo	Traffic Yellow	1023
97	SS-304	Dark blue grey	5008
98	SS-316	Dark violet	4005
99	SS-321	Navy blue	5014

### SAFETY COLOUR SCHEMES

100	DANGEROUS	Black and alert orange band	9005	2008
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	OBSTRUCTION		
101	DANGEROUS OR EXPOSED PARTS OF MACHINERY	Alert orange	2008

Note: All LPG service PSVs shall be painted Deep Blue.

All drains & Vents shall be painted in Main line colour.

The colour code scheme is for identification of piping service group, It consists of a ground colour and 1 / 2 colour bands.

## 20.2 Ground Colour

On uninsulated pipes, the entire pipe has to be painted in ground colour., and on metal cladded insulated lines, minimum 2M long portion should be painted.

## 20.3 Colour Bands

*Location of colour bands:*

- At Battery Limits
- Intersection points & change of direction points in piping
- Midway of piping section, near valves, across culverts
- At 50 M interval on long stretch pipes
- At starting and termination points.

*Minimum width:*

NB	Width
3" and below	75 mm
Above 3" to 6"	NB X 25 MM
Above 6" to 12"	NB X 18 MM
Above 12"	NB X 15 MM

**!!! Note:**  
For insulated pipes, NB indicates OD of the insulation

### Sequence :

Colour bands shall be arranged in sequence showing Table above and the sequence follows the direction of flow. The width of the 1<sup>st</sup> Band to 2<sup>nd</sup> band is 4:1,

**!!! Note :** Wherever deemed required by Process Department or Safety, pipes handling hazardous substances will be given hazard marking of 30 mm wide diagonal stripes of Black and Golden Yellow as per IS : 2379.

## 20.4 Special Camouflage Painting for Uninsulated Crude and Product Storage Tanks.

Paint specification shall be as per standards.

Camouflage painting scheme for Defense requirement in irregular patches will be applied with 3 colours

Dark Green	:	Light green	:	Medium Brown
5	:	3	:	2



The patches shall be irregular and asymmetrical and inclined at 30 to 60 Degrees.

Patches should be continuous at surface meeting lines / points.

Slits / holes shall be painted in dark green shade.

Width of patches shall be 1 to 2 meters.

## 20.5 Identification Markings on Equipment / Piping

Equipment tag Numbers shall be Stenciled / neatly painted using normal 'Arial' Lettering Style on all equipment and piping (Both insulated & uninsulated) after completion of all paint works. Lettering colour shall be either BLACK or WHITE, depending upon the background, so as to obtain good contrast.

Operations Group shall specify location.

Sizes shall be:

Columns, Vessels, Heaters:	150 mm
Pumps and other M/c	50 mm
Piping	OD / 2 with Maximum 100 MM.
Storage Tanks	(As per Drawings)

## 20.6 Colour Coding for Control Valve

- a) Carbon steel body - Light grey  
 Alloy steel body - Canary yellow  
 Stainless steel body - Natural










- b) The actuator of the Control valve shall be painted as :

Direct action (open on air failure) valves - Green

Reverse acting (close on air failure) valves - Red

*The painting Status shall be comprehensively updated every 6 months for compliance*

## 20.7 Colour Coding for Structural & Others

Sl No	Item	Color	Indicative
1	Pipe rack structural	Dark Admiralty Grey	
2	Chequered Plate ( Both faces)	Black	
3	Grating	Black	
4	Ladder Rungs & Railing Vertical Posts	Black	
5	Hand Rail, Middle rail, Toe Plate	Signal Red	
6	Ladder Vertical Posts	Signal Red	
7	Building Structural, Steel Columns, brackets, beams, bracings, roof trusses, purling, side grits, louvers, stringers	Dark Admiralty Grey	
8	Overhead Monorail	Signal Red	
9	Gantry Girder & Monorail	Dark Green	



## 22.0 SELECTION OF PAINT MATERIALS

Paint manufacturers are expected to conduct periodic evaluation/testing of products including long term performance tests which shall include following

- Resistance to Moisture vapour permeability for 2000h (ASTM 2247)
- Cyclic tests for 4200h (ISO7253 & ASTM D 5894-10)
- Resistance to DM water immersion (ASTM D870)
- Chemical Resistance test, ASTM D 1308/D 543/DIN 50905 Part4
- Water vapor transmission, ASTM D1653 & test method B section A -wet cup method, 3 weeks duration

Contractor shall submit MAR (Material Approval Request) along with datasheets, MSDS, relevant information and Test results as indicated below including test results of long term tests for all paint products against system indicated for approval.

Test	Test Method
Specific gravity	ASTM D 1475
Dipping properties	ASTM D 823
Film characteristics	-
Solids content by weight	ASTM D 2369
Drying time	ASTM D 1640
Flexibility	ASTM D 1737/ D 522
Hardness	ASTM D 3363
Adhesion	ASTM D 2197
Abrasion resistance	ASTM D 968/ D 1044
DFT/coat	As per SSPC guidelines
Storage Stability	ASTM D 1849
100% Humidity test, duration 2000 hrs,	ASTM D 2247
% Zn in Dry film for Inorganic Zinc Silicate primer	ASTM D 521
Chemical Resistance test - 10% & 40% NaOH (applicable only for F-6A F-6C,F-7, F-14, F-15 and F-17) - 10% H <sub>2</sub> SO <sub>4</sub> (applicable only for F-6A F-6C,F-7, F-14, F-15 and F-17) - 10 % Nitric Acid test (applicable only for F-15 and F-17) - Xylene, Acetone, Ethanol, Kerosine (applicable only for F-6A, F-6C, F-9, F-15 and F-17) - Sea water (applicable only for F-6A, F-6C, F-7, F-14, F-15, F-17) - 5% Ammonium sulphate and 5% Ferric Chloride(applicable only for F-6A, F-6C, F-7, F-8, F-13, F-14, F-17) - Glacial acetic acid (applicable only for F-15 and F-17) - MIBK test (applicable only for F-2, F-6 A/B/C, F-8, F-9, F-15 and F-17)	ASTM D 543

Cyclic Test for the duration of 4200 h Salt spray: 72h;Drying in air:16 h; UV-A 340 nm weatherometer: 80 h One cycle: 168 h (25 cycles at 168 hours each cycle) (Applicable for all except P2, F16, F11, F12, F14)	ISO 7253, ASTM 5894
Resistance to water immersion (applicable only for F11, F12, F15, F16, F17)	ASTM D 870
Dry Heat Resistance test (Method B-applicable only for F-9,F11,F12,F15,F16,F17) (Method A- applicable only for P6, F2,F-6A/B/C,F7,F14)	ASTM D 2485
Water vapor transmission, & test method B section A - wet cup method, 3 weeks duration (applicable only for F9, F11, F12, F16)	ASTM D 1653
Thermal shock resistance test (only for F-9, F-6, poly-siloxane)	ASTM D 2485 - 91

The contractor shall be fully responsible for the quality of the paints meeting technical requirements of the products as per approved datasheets. Along with the delivery of the paint products, the contractor shall furnish batch wise test report from the manufacturer.

Once the paint material is supplied to site, In addition to the quality control system as specified in section 13.0, for each product, the supplier shall organize random sampling and testing in a *third party laboratory* as per discretion of the Engineer-in-charge. Failing to meet the specified quality requirements may cause rejection of the paint products.

## 23.0 QUALITY CONTROL, INSPECTION AND TESTING

23.1 All painting materials including primers and thinners brought to site by contractor for application shall be procured directly from manufactures as per specifications and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates are not acceptable (see section 12.0).

The painting work shall be subject to inspection by Engineer-In-Charge at all times. In particular, following stage-wise inspection will be performed and contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection are as follows:

- (a) Surface preparation
- (b) Primer application
- (c) Each coat of paint

### 23.2 During surface preparation, following tests are to be carried out:

- Test for presence of oil/grease and contamination

The steel substrate after degreasing as per SSPC-SP 1 shall be tested as per following procedure to validate absence of oil and grease contamination.

- a) Visual inspection - Continue degreasing until all visible signs of contamination are removed.

b) Conduct a solvent evaporation test by applying several drops or a small splash of residue-free tri-chloromethane on the suspect area especially pitting, crevice corrosion areas or depressed areas. An evaporation ring formation is indicative of oil and grease contamination.

Continue degreasing and inspection till test is passed.

- Tests for surface finish of blasted surface shall be done by visual inspection using SSPC-VIS1. Clear cellophane tape test as per ISO 8502-3 shall be used to confirm absence of dust on blasted surface. Checks shall be done on each component at least once per 200 m<sup>2</sup> of blasted surface and minimum of 3 checks per shift.
- Test for presence of soluble salt as per method ISO 8502-9. Maximum allowable salt content shall be considered 20 mg/m<sup>2</sup> (2 mg/cm<sup>2</sup>). Checks shall be done on each component at least once per 200 m<sup>2</sup> of blasted surface and minimum of 3 checks per shift. In case salt exceeds specified limit, the contaminated surface shall be cleaned by method as per Annexure-C of IS 12944-4 (water cleaning). After cleaning surface shall be retested for salt after drying.
- Blast Profile Measurement:

The angular profile depth measurement shall be done by profile tape as per method NACE Standard RP 0287 or ASTM D 4417 method B (Profile depth gauge micrometer). Spot measurement shall be carried out every 15m<sup>2</sup> of blasted surface. At each spot three measurements shall be taken over an area of 10 cm<sup>2</sup> and average of measurements to be recorded and reported.

If profile is <65 microns blasting shall continue till greater than 65 microns depth profile is achieved.

- Tests for blasting media, blasting air

Blasting Media (For every fresh batch of media and one random test during blasting)

Blasting Media shall be visually inspected for absence of contamination and debris using 10 X magnification.

a) Inspection for the absence of oil contamination shall be conducted using following procedure:

- Fill a small clean 200 ml bottle half full of abrasive.
- Fill the bottle with potable water, cap and shake the bottle.
- Inspect water for oil film/slick. If present, the blasting media is not to be used.

b) Soluble salt contamination if suspected shall be verified by method ASTM D 4940. If present, media to be replaced.

c) Clean blasting equipment, especially pot and hoses, and then replace blasting media and retest.

Test for Blasting Air (Once Daily before start of blasting and once at random during blasting)

The air for blasting shall be free from moisture and oil. The compressor air shall be checked for oil and water contamination per ASTM D 4285.

In addition to above, record should include type of shop primer already applied on equipment e.g. zinc silicate, or zinc rich epoxy, or zinc phosphate.

Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer-In-Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, contractor shall be responsible for making good any defects found during final inspection/guarantee period/defect liability period as defined in general condition of contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make-up the DFT specified without any extra cost to owner, the extra coat should have prior approval of Engineer-in-charge.

### 23.3 Primer Application

After surface preparation, the primer should be applied to cover the crevices, corners, sharp edges etc. in the presence of inspector nominated by Engineer-In-Charge.

The shades of successive coats should be slightly different in colour in order to ensure application of individual coats, the thickness of each coat and complete coverage should be checked as per provision of this specification. This should be approved by Engineer-In-Charge before application of successive coats.

The contractor shall provide standard thickness measurement instrument with appropriate range(s) for measuring.

Dry film thickness of each coat, surface profile, gauge for checking of surface profile in case of sand blasting. Holiday detectors and pinhole detector & protector whenever required for checking in case of immersion conditions.

Prior to application of paints on surfaces of chimneys, the thickness of the individual coat shall be checked by application of each coat of same paint on M.S.test panel. The thickness of paint on test panels shall be determined by using gauge such as 'Elko meter'. The thickness of each coat shall be checked as per provision of this specification. This shall be approved by Engineer-In-Charge before application of paints on surface of chimney.

At the discretion of Engineer-In-Charge, the paint manufacturer must provide the expert technical service at site as and when required. This service should be free of cost and without any obligation to the owner, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations. The contractor is responsible to arrange the same.

### 23.4 Final inspection of finished coating shall consist of measurement of:

- 1) Paint dry film thickness (DFT)
  - 2) Adhesion
  - 3) Holiday detection check as well as for finish and workmanship.
- 
- 1) **Coating DFT** measurement shall be as per ISO 2808. Type II electromagnetic gauges should be used for ferrous substrates. DFT gauge calibration, number of measurement shall be as per SSPC-DA 2. Measured DFT shall be within + 10% of the dry film thickness, specified in the specifications.
  - 2) **Adhesion** of the primer to the steel substrate and intercoat adhesion of the subsequent coat(s) after curing for at least a week after application of the topcoat shall be examined by a knife test in accordance with ASTM D 6677. For the knife test, if the rating is better than

8, the adhesion is considered acceptable. The adhesion is destructive and tested areas shall be repaired afterward using the spot repair procedure. Alternatively, the applicator may perform the adhesion test on a steel panel coated using the same surface preparation and coating application procedure as the work piece. Adhesion testing shall be carried out for each component at least once per 200 m<sup>2</sup> (2000 ft<sup>2</sup>) of coated surface.

- 3) **Holiday testing** shall be conducted in accordance with NACE SP 0188. For immersion services, 100% of coated area shall be inspected for holidays. For atmospheric exposure, 10% of coated area which must include weld seams, corners and edges to be holiday tested. Voltage at which test is to be carried out will depend upon DFT of coating being tested and shall be as per NACE SP 0188. Any holiday is unacceptable and should be marked and repaired immediately.

The contractor shall arrange for spot checking of paint materials for Specific gravity, glow time (ford cup) and spreading rate.

### **23.5 Final Inspection of coating system**

A final inspection shall be conducted prior to the acceptance of the work. The coating contractor and the facility owner shall both be present and they shall sign an agreed inspection report. Such reports shall include:

#### General

- Names of the coating contractor and the responsible personnel
- Dates when work was performed

#### Coating Materials

- Information on coating materials being applied
- Condition of coating materials received

#### Environmental Conditions

- Weather and ambient conditions
- Coating periods

#### Surface Preparation

- Condition of surface before preparation
- Tools and methods used to prepare surface
- Condition of surface after preparation

#### Coating Application

- Equipment used
- Mixing procedure prior to application
- Coating application techniques used

#### Testing

- Type and calibration of inspection instruments used
- Type of quality control tests performed, and results

### **24.0 GUARANTEE**

The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/to be provided during execution of work.