JOB SPECIFICATION SHOP&FIELD PAINTING SMMS DEPARTMENT

CFBC BASED CAPTIVE POWER PLANT

PROJECT : BINA REFINERY

OWNER : BHARAT OMAN REFINERIES LTD.,(BORL)

PMC : ENGINEERS INDIA LTD.

JOB NO. : 6743

NO.	DATE	REVISION
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Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

Abbreviations:

AS	:	Alloy Steel
CS	:	Carbon Steel
DFT	:	Dry Film Thickness
DM	:	De-mineralized
GI	:	Galvanized Iron
ID	:	Internal Diameter
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

1.0 GENERAL

1.1 These technical specifications shall be applicable for the work covered by the contract, and without prejudice to the various 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.

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 paints on external surfaces of equipment, vessels, machinery, piping, ducts, steel structures, external & internal protection of storage tanks for all services, external surfaces of MS Chimney with or without Refractory lining and Flare lines etc. The items listed in the heading of tables of paint systems is indicative only, however the contractor is fully responsible for supply of all paint materials carrying out all the necessary painting, coating and lining on external and internal surfaces as the tender requirement.

2.2 Extent of Work

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

a. All uninsulated C.S. & A.S. equipment like columns, vessels, drums, storage tanks, heat exchangers, pumps, compressors, electrical panels and motors etc. and tanks and equipment in ETP plant
b. All uninsulated carbon and low alloy piping fittings and valves (including painting of identification marks), furnace, ducts and stacks.
c. All items contained in a package unit as necessary.
d. All structural steel work, pipe, structural steel supports, walkways, handrails, ladders, platforms etc.
e. External surfaces of MS Chimneys with or without refractory lining & Flare lines.
f. Identification colour bands on all piping as required including insulated aluminum clad, galvanized, SS and nonferrous piping.
g. Identification lettering/ numbering on all painted surfaces of equipment/piping insulated aluminum clad, galvanized, SS and non-ferrous piping
h. Marking / identification signs on painted surfaces of equipment/piping Hazardous service.
i. Supply of all primers, paints and all other materials required for painting other than Owner's supply
j. Over insulation surface of equipments and pipes wherever required.
k. Painting under insulation for carbon steel and stainless steel as specified.
l. Repair work of damaged/ pre-erection/ fabrication shop primer and weld joints at field.
m. Internal surfaces of RCC tanks and structures in Effluent Treatment Plant

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

a. Uninsulated austenitic stainless steel.
b. Plastic and/or plastic coated materials
c. Non-ferrous materials like aluminum, galvanized "piping", "gratings" and "Handrails" etc. except G.I. Tower.

2.3 Unless otherwise instructed final painting on pre-erection/ shop primed pipes and equipments shall be painted in the field, only after the mechanical completion, testing on systems are completed as well as after completion of steam purging wherever required.

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

3.0 CODES & STANDARDS

3.1 Without prejudice to the provision of Clause 1.1 above and the detailed specifications of the contract, the following codes and standards shall be followed for the work covered by this contract.

Colour coding :	Paint Colour Code for Piping
IS-101	Methods of test for ready mixed paints and enamels.
ASTM	American standard test methods for paints and coatings.
ASA A 13.1-1981	Scheme for identification of piping systems: American National Standards Institution.

3.2 Surface Preparation Standards

Following standards shall be followed for surface preparations:

3.2.1 Swedish Standard - SIS-05 5900-1967 (Surface preparations standards for Painting Steel Surfaces).

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 British Standards (Surface Finish of Blast-cleaned for Painting) BS-4232.

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

3.2.5 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. 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.
c. Mixing and thinning.
d. Application of paints and recommended limit on time intervals 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/sand 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.

4.2 Mechanical mixing 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.

5.0 SURFACE PREPARATION, NON COMPATIBLE SHOP PRIMER, COATING PROCEDURE, 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 steel surface 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. Manual or hand tool cleaning.
b. Mechanical or power tool cleaning.
c. Blast 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. The minimum acceptable standard in case of manual or hand tool cleaning shall be St. 2 or equivalent, in case of mechanical or power tool cleaning it shall be St. 3 or equivalent in case of blast cleaning it shall Sa 2-1/2 OR equivalent as per Swedish Standard SIS-055900-1967 or equivalent. Where highly corrosive conditions exist, then blast cleaning shall be Sa 3 as per Swedish Standard.

Remove all other contaminants, oil, grease etc. by use of an aromatic solvent prior to surface cleaning.

5.1.3 Blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceed 85%.

5.1.4 Irrespective of the method of surface preparation, the first coat of primer must be applied by brush on dry surface. This should be done immediately and in any case within 4 hours of cleaning of surface. However, at times of unfavourable 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 unfavourable weather conditions, blasting and painting shall be avoided as far as practicable.

5.1.5 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 if necessary 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 then dry completely before application of paint.

5.2 **Procedure of Surface Preparation** :

5.2.1 Blast Cleaning

5.2.1.1 Air Blast Cleaning

The surfaces shall be blast cleaned using one of the abrasives: $A1_2O_3$ particles chilled cast iron or malleable iron and steel at pressure of 7kg/cm^2 at appropriate distance and angle depending of nozzle size maintaining constant velocity and pressure. Chilled cast iron, malleable iron and steel shall be in the form of shot or grit of size not greater than 0.055" maximum in case of steel and malleable iron and 0.04" maximum in case of chilled iron. 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 ¾". 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 or 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.

5.2.1.2 Water Blast cleaning

Environmental, health and safety problems associated with abrasive blast cleaning limit the application of Air Blast Cleaning in many installations. In such case water blast cleaning is resorted to.

Water Blast cleaning can be applied with or without abrasive and high pressure water blasting. The water used shall be inhibited with sodium chromate/ phosphate. The blast cleaned surface shall be washed thoroughly with detergents and wiped with solvent and dried with compressed Air. For effective cleaning abrasives are used. The most commonly used pressure for high pressure water blast cleaning for maintenance surface preparation is 3000 to 6000 psi at 35-45 liters/minute water volume and pressures upto 10000 psi and water volume of 45 litres/minute provide maximum cleaning.

The water blast cleaned surface shall be comparable to SSPC-SP-12/nace No.5. The operation shall be carried out as per SSPC guidelines for water Blast cleaning. The indicative values for sand injection is:

Air	:	300 to 400 Cu.ft/min.
Water	:	5-10 litres/min. with corrosion inhibitor
Sand	:	200-400 lbs/hr.
Nozzle	:	0.5 to 1" dia

Special equipments for water blast cleaning with abrasives now available shall be used.

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.

5.2.3 Manual or hand tool cleaning

Manual or hand tool cleaning is used only where safety problems limit the application of other surface preparation procedure and hence does not appear in the tables of paint systems.

Hand tool cleaning normally consists of the following :

a. Hand de-scaling and/or hammering
b. Hand scraping
c. Hand wire brushing

Rust, mill scale spatters, old coatings and other foreign matter, shall be removed by hammering, scrapping tools, emery paper cleaning, wire brushing or combination of the above methods. On completion of cleaning, loose material shall be removed from the surface by clean rags and the surface shall be bushed, swept, dusted and blow off with compressed air/steam to remove all loose matter. Finally the surface may be washed with water and dried for effective cleaning.

5.3 **Non-Compatible shop coat primer**

The compatibility of finishing coat should be confirmed from the paint manufacturer. In the event of use of primer such as zinc Rich epoxy, inorganic zinc silicate etc. as shop coat, the paint system shall depend on condition of shop coat. If the shop coat is in satisfactory condition showing no major defect, the shop coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer-in-Charge.

5.4 Shop coated (coated with Primer & finishing coat) equipment should not be repainted unless paint is damaged.

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.

5.7 Coating Procedure and 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.

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.

5.7.6 Air spray application shall be in accordance with the following:

a. The equipment used shall be suitable for the intended purpose, shall be capable of properly atomizing the paint to be applied, and shall be equipped with suitable pressure regulators and gauges. The air caps, nozzles, and needles shall be those recommended by the manufacturer of the equipment for the material being sprayed. The equipment shall be kept in satisfactory condition to permit proper paint application.

b. Traps or separators shall be provided to remove oil and condensed water from the air. These traps or separators must be of adequate size and must be drained periodically during operations. The air from the spray gun impinging against the surface shall show no condensed water or oil.

c. Ingredients shall be kept properly mixed in the spray pots or containers during application by continuous mechanical agitation.

d. The pressure on the material in the pot and of the air at the gun shall be adjusted for optimum spraying effectiveness. The pressure on the material in the pot shall be adjusted when necessary for changes in elevation of the gun above the pot. The atomizing air pressure at the gun shall be high enough to properly atomize the paint but not so high as to cause excessive fogging of paint, excessive evaporation of solvent, or less by over spray

e. Spray equipment shall be kept sufficiently clean so that dirt, dried paint, and other foreign materials are not deposited in the paint film.

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

f. Paint shall be applied in a uniform layer, with overlapping at the edge of the spray pattern. The spray patterns shall be adjusted so that the paint is deposited uniformly. During application, the gun shall be held perpendicular to the surface and at a distance which will ensure that a wet layer of paint is deposited on the surface. The trigger of the gun should be released at the end of each stroke.

g. All runs and sags shall be brushed out immediately or the paint shall be removed and the surface repainted.

h. Areas inaccessible to the spray gun shall be painted by brush; if not accessible by brush, daubers or sheepskins shall be used.

i. All nameplates, manufacturer's identification tags, machined surfaces, instrument glass, finished flange faces, control valve items and similar items shall be masked to prohibit coating deposition. If these surfaces are coated, the component shall be cleaned and resorted to its original condition.

j. Edges of structural shapes and irregular coated surfaces shall be coated first and an extra pass made later.

k. If spray gun shows choking, immediately de-choking procedure shall be followed.

5.7.7 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 sued 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 automization 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 inbuilt agitator that keep the paint uniformly mixed during the spraying. The unit shall consists of inbuilt strainer. Usually very small quantities 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.

5.7.8 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, daubers, or sheepskin.

5.7.9 Manual application by sling (where 6 O' clock position of pipe is not approachable)

A canvas strip (alternatively a tinplate strip) about 450 mm wide and 1.5m long is hold under the pipe by two men holding this sling move it up and down and walk slowly forward while fresh coating is poured on the pipe and they manipulate the sling so that an even coating is obtained all round the bottom. This work shall be done very carefully and by experienced personnel. There shall not be any formation of "Whiskers" and holes in the coating. The coating film shall be inspected by mirror.

5.7.10 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 mixing is faulty.

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

5.8.3 No drier shall be added to a 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 **Repair of damaged paint surface**

5.9.1 Where paint has been damaged in handling and in transportation, the repair of damaged coating of pre-erection/fabrication shall be as given below.

5.9.2 Repair of damaged inorganic zinc silicate primer after erection/welding:

Quickly remove the primer from damaged area by mechanical scraping and emery paper to expose the white metal. Blast clean the surface if possible. Feather the primer over the intact adjacent surface surrounding the damaged area by emery paper.

5.9.3 Repair of damaged pre-erection and shop priming in the design temperature of -90^{o} C to 400^{o} C.

- Surface preparation shall be done as per procedure 5.9.2.

- One coat of F-9 shall be applied wherever damaged was observed on pre-erection/pre-fabrication/shop primer of inorganic zinc silicate coating (F-9). F-9 shall not be applied if damaged area is not more than 5x5 cm.

5.10 **Paint Application**

5.10.1 Shop priming/pre-erection priming with F9 or F12 shall be done only on blasted surface.

5.10.2 Shop priming/ pre-erection priming with F9 or F12 shall be done only with airless spray.

5.10.3 For large flat surface field painting shall be done by airless spray otherwise brush can be used.

5.11 **Documentation**

5.11.1 A written quality plan with procedure for qualification trials and for the actual 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 programme.

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.

TABLE-1 (FOR CLAUSE 5.0)
SURFACE PREPARATION STANDARDS

SL. NO.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)				REMARKS
		SWEXISH STANDARD SIS-05-5900	SSPC-SP USA	NACE, USA	BRITISH STANDARD BS-4232;	
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	Blast cleaning (air & water) 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	First Quality	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	Second Quality	The minimum requirement for chemically resistant paint systems such as epoxy, vinyl, polyurethane based and inorganic zinc

SL. NO.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)				REMARKS
		SWEXISH STANDARD SIS-05-5900	SSPC-SP USA	NACE, USA	BRITISH STANDARD BS-4232;	
						silicate paints, also for conventional paint systems used under fairly corrosive conditions to obtain desired life of paint system.
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	Third Quality	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 printed literature, alongwith the test certificate for all specified characteristics given in this specification. All the paint materials shall be on first quality and conform to the following general characteristics. As per the tables 6.1, 6.2 and 6.3.

TABLE No. 6.1 PRIMERS

Sl. No.	DESCRIPTION	P-2	P-4	P-6
1	Technical name	Chlorinated rubber Zinc Phosphate primer.	Etch primer/wash primer	Epoxy zinc phosphate primer
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 polyamide cured epoxy resin medium, pigmented with zinc phosphate.
3	Volume Solids (approx.)	40%.	7-8%	40%
4	DFT (Dry Film thickness) per coat (approx.)	40-45µ	8-10µ	40-50µ
5	Theoritical covering capacity in M^2/coat/litre (approx.)	8-10	8-10	8-10
6	Weight per litre in kgs/litre (approx.)	1.3	1.2	1.4
7	Touch dry at 30°C (approx.)	30 minutes	2 hrs.	After 30 min.
8	Hard dry at 30°C (approx.)	24 hrs.	24 hrs.	24hrs
9	Overcoating interval (approx.)	Min. : 8 hrs Max.: No limitations	Min : 4-6 hrs. Max.: 24 hrs.	Min.: 8 hrs. Max.: 3-6 months
10	Pot life (approx.) at 30°C for two component paints (approx.)	Not Applicable	Not applicable	8 hrs.

TABLE No. 6.2 FINISH PAINTS

Sl. No	DESCRIPTION	F-2	F-3	F-6A/B	F-7
1	Technical name	Acrylic Polyurethane finish paint	Chlorinated rubber based finish paint	Epoxy-High Build finish paint.	High build coaltar epoxy coating.
2	Type and composition	Two-pack aliphatic isocynate cured acrylic finish paint.	Single pack plasticised chlorinated rubber based medium with chemical and weather resistant pigments.	Two-pack F-6 A polyamine cured/ polyamide cured F-6B epoxy resin medium suitably pigmented	Two pack polyamide cured epoxy resin blended with coaltar medium, suitably pigmented
3	Volume Solids (approx.)	40%.	40%	62%	65%
4	DFT (Dry Film thickness) per coat (approx.)	30-40µ	40-45	100-125µ	100-125µ
5	Theoritical covering capacity in M^2/coat/litre (approx.)	10-13	8-10	5-6	5.2-6.5
6	Weight per liter in kgs/litre(approx.)	1.3	1.2	1.4	1.5
7	Touch dry at 30°C (approx.)	1 hr.	30 minutes.	3 hrs.	4 hrs.
8	Hard dry at 30°C (approx.)	Overnight	8 hrs	Overnight	48 hrs.
9	Overcoating interval (approx.)	Min.: Overnight (12 hrs.) Max.: Unlimited	Min.: Overnight Max.: Unlimited	Min.: Overnight Max.: 5 days	Min.: 24 hrs Max.: 5 days.
10	Pot life (approx.) at 30°C for two component paints (approx.)	6-8 hrs.	Not applicable	4-6 hrs	4-6 hrs.

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 Aluminum paint suitable upto 250°C dry temp.	Heat resistant silicone Aluminum paint suitable upto 500°C dry temp.
2	Type and 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	Heat resistant synthetic medium based two pack Aluminum paint suitable upto 250°C.	Single pack silicone resin based medium with Aluminum flakes.
3	Volume Solids (approx.)	72%.	60%	25%	20%
4	DFT (Dry Film thickness) per coat (approx.)	100-125µ	65-75µ	20-25µ	20-25µ
5	Theoritical covering capacity in M^2/coat/litre (approx.)	6.0-7.2	8-9	10-12	8-10
6	Weight per liter in kgs/litre(approx.)	1.4	2.3	1.2	1.1
7	Touch dry at 30°C (approx.)	3 hrs.	30 mts.	3 hrs.	30 mts.
8	Hard dry at 30°C (approx.)	24 hrs	12 hrs	12 hrs	24 hrs
9	Overcoating interval (approx.)	Min.: 10 hrs Max.: 6 months	Min.: 8 hrs.at 20°C & 50% RH Max.: unlimited	Min.: 16 hrs Max.: Unlimited	Min.: 16 hrs Max.: unlimited
10	Pot life (approx.) at 30°C for two component paints (approx.)	90 mts.	4-6 hrs.	Not applicable	Not applicable
11	Temperature Resistance	-	-	250°C	500°C.

F-14: Specially formulated polyamine cured coaltar epoxy suitable for -45°C to 125°C for application under insulation

F-15: Two pack ambient temperature curing epoxy phenolic coating suitable for -45°C to 125°C for application under insulation

F-16: Engineered Poly siloxane Coating : Amercoat 738 from Ameron Products, USA/ : Berger 938 from Berger Paints Ltd., Kolkata

NOTES :

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.

4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.

6.4 List of recommended Manufactures

The paints shall conform to the specifications given above and best quality in their products range of manufacturers listed in Annexure–I.

7.0 PAINT SYSTEMS

The paint system should vary with type of environment envisaged in and around the plants. Three types of environment as given below are considered for selection of paint system. The paint system is also given for specific requirements.

PRIMERS & FINISH COATS COVERED IN TABLE NOS. 7.0 TO 15.0

PRIMERS

P-2	:	Chlorinated rubber zinc Phosphate Primer
P-4	:	Etch Primer/Wash Primer
P-6	:	Epoxy Zinc Phosphate Primer

FINISH COATS/PAINTS

F-2	:	Acrylic – Polyurethane finish paint
F-3	:	Chlorinated Rubber finish paint
F-6A	:	High Build Epoxy finish coating cured with polyamine hardner
F-6B	:	High Build Epoxy finish coating cured with polyamide hardner
F-7	:	High build Coal Tar epoxy coating
F-8	:	Self priming surface Tolerant High Build epoxy coating.
F-9	:	Inorganic Zinc Silicate coating
F-11	:	Heat resistant synthetic medium based Aluminum paint
F-12	:	Heat resistant Silicone Aluminum paint.
F-14	:	Specially formulated polyamine cured coal for Epoxy coating suitable up to 150 deg.C
F-15	:	Epoxy phenolic coating
F-16	:	Epoxy Siloxane Coating

TABLE 7.1 : PRE-ERECTION /PRE-FABRICATION & SHOP PRIMING FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL, STEEL UNINSULATED AND INSULATED STRUCTURES, PIPING & EQUIPMENT ETC.

Sl. No.	Desigh Temperature in ^{o}C	Surface preparation	Paint system	Total DFT in Microns (min.)	Remarks
7.1.1	-90 to 400	SSPC-SP-10	1 coat of F-9	65-75	No overcoating is to be done.
7.1.2	401 to 500	SSPC-SP-10	2 coats of F-12	40-50	Finish coat at site.

TABLE 7.2 REPAIR OF PRE-ERECTION/PRE-FABRICATION & SHOP PRIMING AFTER ERECTION/WELDING FOR CARBON STEEL, LOW TEMPERTURE CARBON STEEL & LOW ALLOY STEEL UNINSULATED AND INSULATED ITEMS IN ALL ENVIRONMENTS.

Sl. No.	Design Temp. in ^{o}C	Surface Preparation	Paint System	Total DFT in Microns (min.)	Remarks
7.2.1	-90 to 400	SSPC-SP-3(for repair only) SSPC-SP-10	1 coat of F-9	65-75	
7.2.2	401 to 500	SSPC-SP-3 (for repair only) SSPC-SP-10	2 coats of F-12	40-50	

TABLE 7.3 REPAIR OF ALL WELD JOINTS AND DAMAGES OF GALVANIZED STEEL, CARBON STEEL AND ALLOY STEEL STRUCTURES, PIPING AND EQUIPMENT AFTER ERECTION ON ABOVE GROUND OVERHEAD AREAS AT SITE:

Sl. No.	Design Temp. in ^{o}C	Surface Preparation	Paint System	Total DFT in Microns (min.)	Remarks
7.3.1	-14 to 80	SSPC-SP-3	1 coat of F-8	100	
7.3.2	81 to 500	SSPC-SP-3	1 coat of F-12	20	.

Note; F-12 and F-9 shall be applied on blast cleaned surfaces only
F-12 requires shall be ambient temperature curing type till the complete curing is achieved during operating temperature as per the manufacturer's recommendations.

TABLE 8.0 : FIELD PAINT SYSTEM FOR NORMAL CORROSIVE ENVIRONMENT (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL) IN OFFSITE AREAS FOR UNINSULATED STRUCTURES, PIPING, EQUIPMENT, FLARE LINES ETC.,

Sl. No.	Design Temperature in ^{o}C	Surface Preparation	Paint system		Total DFT In Microns (min.)	Remarks
			Field primer	Finish paint		
8.1	-90 to -15	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75µ DFT/coat	None	65-75	No over coating to be done. Follow repair procedure only on damaged areas of pre-erection/ pre-fabrication primer/ Coating F-9 F-12 shall be ambient temperature curing type till operating temperature is attained for full curing.
8.2	-14 to 60	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75µ DFT/coat + 2 coats of P-2 @ 40µ DFT/Coat 2x40=80	2 coats of F-3 @ 40µ DFT/ Coat 2x40=80	225	
8.3	61 to 80	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75µ DFT/coat + 2 coats of P-6 @ 40µ DFT/Coat 2x40=80	1 coat of F-6B@ 100µ DFT/Coat	245	
8.4	81 to 250	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75µ DFT/coat	3 coats of F-12 @ 20µ DFT/Coat 3x20=60	125	
8.5	251 to 400	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75µ DFT/coat	2 coats of F-12 @ 20µ DFT/Coat 2x20=40	105	
8.6	401 to 500	SSPC-SP-10	Repair as per 7.2.2.	2 coats of F-12 @ 20µ DFT/Coat 2x20=40	80	

NOTE 1: For external surfaces of MS chimney with or without refractory lining 8.3, 8.4 and 8.5 shall be followed.

NOTE 2: For external surfaces of RCC chimney: 2 coats of F-6B @ 100µ DFT/Coat to obtain 2x100=200µ DFT shall be applied after making surface preparation as per guidelines in 5.1.5.

NOTE 3: Wherever required S.No.8.3 shall be used for –14^{o}C to 80^{o}C and S.No.8.2 will be deleted.

TABLE 9.0 FIELD PAINT SYSTEM FOR CORROSIVE ENVIRONMENT (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL) IN PLANT AREA:

For all corrosive areas above ground where H_2S, SO_2 fumes or spillages of acid/Alkali/Salt are likely to come in contact with surfaces such as external surfaces of un-insulated columns, vessels, heat exchangers, blowers, piping, pumps, towers, compressors, and structural steel etc.

Sl. No.	Design Temperature in °C	Surface Preparation	Paint System		Total DFT in Microns (min.)	Remarks
			Field Primer	Finish Paint		
9.1	-90 to -15	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75µ DFT/coat	None	65-75	Repair of pre-erection / pre-fabrication primer shall be done wherever damage is observed. Surface preparation is required only for repairing of damaged pre-erection/ fabrication primer.
9.2	-14 to 80	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75µ DFT/coat + 1 coats of P-6 @ 40µ DFT/coat	1 coat of F-6A @ 100µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat.	245	
9.3	81 to 400	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75µ DFT/coat	2 coats of F-12 @ 20µ DFT/coat 2x20=40	105	
9.4	401 to 500	SSPC-SP-10	Repair as per 7.2.2.	2 coats of F-12 @ 20µ DFT/coat 2x20=40	80	

TABLE 10.0 : FIELD PAINT SYSTEM FOR HIGHLY CORROSIVE AREAS IN PLANT AREA (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL) EXTERNAL SURFACES OF UNINSULATED COLUMNS, VESSELS, HEAT EXCHANGERS, BLOWERS, PIPING, PUMPS, TOWERS, COMPRESSORS, STRUCTURAL STEEL ETC.

Exposed to spillage or fumes of HCL, H_2SO_4, salty water, water impingement, chloride etc.

Sl. No.	Design Temperature in ^oC	Surface Preparation	Paint System		Total DFT In Microns (min.)	Remarks
			Field Primer	Finish Paint		
10.1	-90 to -15	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75µ DFT/coat	None	65-75	Repair procedure of pre-erection/fabrication primer shall be followed. No overcoating is allowed. Surface preparation is required only for repairing of damaged pre-erection/ fabrication primer.
10.2	-14 to 80	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75µ DFT/coat + 1 coats of P-6 @ 40µ DFT/Coat	2 coats of F-6A @ 100µ DFT/Coat = 2x100=200 + 1 coat of F-2 @ 40µ DFT/coat.	345	
10.3	81 to 400	SSPC-SP-10	Repair of pre-fabrication primer 1 coat of F-9 @ 65-75µ DFT/coat	2 coats of F-12 @ 20µ DFT/Coat 2x20=40	105	
10.4	401 to 500	SSPC-SP-10	Repair as per 7.2.2.	2 coats of F-12 @ 20µ DFT/Coat 2x20=40	80	

TABLE 11.0 : FIELD PAINT SYSTEM FOR CARBON STEEL STORAGE TANK (EXTERNAL) FOR ALL ENVIRONMENTS.

Sl. No.	Design Tempera-ture In ^{o}C	Surface Preparation	Paint System		Total DFT in Microns (min.)	Remarks
			Field Primer	Finish Paint		
11.1	External shell, wind girders, apparntuses, roof tops of all above ground tank including top side of floating roof of open tank as well as covered floating roof tank and associated structural works, rolling and stationary ladders, spiral stairways, hand rails for all environments for crude oil, LDO, HSD, ATF, Kerosene, Gasolene, motor spirit, DM water, firewater, raw water, potable water, acids, alkalies solvents and chemicals etc.					
11.1.1	-14 to 80	SSPC-SP-10	1 coat of F-9* @ 65-75µ DFT/coat + 1 coats of P-6 @ 40µ DFT/coat 65+40=105	1 coat of F-6A @ 100µ DFT/coat + 2 coats of F-2 @ 40µ DFT/coat 2x40=80	245	F-6 should be suitable for occasional water immersion
11.1.2	81 to 500	SSPC-SP-10	1 coat of F-9* @ 65-75µ DFT/coat	2 coats of F-12 @ 20µ DFT/coat 2x20=40	105	
11.2	External surfaces of bottom plate (soil side) for all storage tanks.					
11.2.1	-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	F-7 should be suitable for immersion service of the products given

* Same as pre-erection/ pre-fabrication primer.

TABLE 12.0 : FIELD PAINT SYSTEM FOR CARBON STEEL AND ALLOY STEEL STORAGE TANKS (INTERNAL)

Sl. No.	Design Temperature In °C	Surface Preparation	Paint System		Total DFT in Microns (min.)	Remarks
			Field Primer	Finish Paint		
12.1	Internal surfaces of underside of floating roof, internal surface of cone roof, bottom plate, roof structures, structural steel, ladders, supports for storing crude oil, LDO, and HSD (Excluding white oil products)					
12.1.1	-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	F-7 should be suitable for immersion service of the products given.
12.2	Bare shell of inside floating roof tanks and cone roof tanks for products mentioned in 12.1					
12.2.1	-14 to 80	SSPC-SP-10	Phosphating treatment with phosphating chemicals(2 coats)	2 Coats @ 10µ 2X10=20	20	
12.3	Floating cone roof tanks for petroleum products such as ATF, Gasoline, Naptha, Kerosene, Motor spirit, inside of bottom plate, underside of floating roof and shell above maximum liquid level and structural steel, ladders etc.					
12.3.1	-14 to 80	SSPC-SP-10	1 Coat of F-9 @ 65-75µ DFT/Coat	3 Coats of F-6A @ 100µ DFT/ Coat 3X100=300	365	F-6 should be suitable for immersion service of petroleum products like ATF, Kerosene petrol etc
12.4	Bare shell of inside of floating cone roof tanks for products mentioned in 12.3.					
12.4.1	-14 to 80	SSPC-SP-10	1 Coat of F-9 @ 65-75µ DFT/Coat	None	65-75	No over coating is allowed. Same as per pre-erection primer, if any.
12.5	Internal protection of fixed roof type storage tanks for potable water: Inside of shell, under side of roof and roof structure inside surface, bottom plate and structural steel works, ladders, walkways, platforms etc.					
12.5.1	-14 to 80	SSPC-SP-10	2 Coats of P-6 @ 40µ DFT/ coat 2X40=80	2 Coats of F-6B @ 100µ DFT/ Coat 2X100=200	280	F-6B shall be suitable for immersion service.
12.6	D.M. (Demineralised water) and hydrochloric acid (HCL): Internal shell, bottom plate & all accessories					
12.6.1	-14 to 60	SSPC-SP-10	Natural Rubber lining as per SMMS specifications 6-06-204			
12.7	EG tanks (internal shell, bottom plate roof and all accessories)					
12.7.1	All	SSPC-SP-10	3 coats vinyl chloride co-polymer Amercoat 23 @ 75µ /Coat		225	
12.8	Inside pontoon and inside of double deck of all floating roofs.					
12.8.1	-14 to 80	SSPC-SP-10	1 Coat of F-8 @ 100µ DFT/Coat		200	
12.9	Internal surfaces of amine & sour water storage tanks					
12.9.1	-14 TO 80	SSPC-SP-10	1 Coat of F-9 @ 65-75µ DFT/Coat	2 coats of F-15 @ 75µ DFT/coat 2x75 = 150	215-225	

TABLE 13.0 : COATING SYSTEM FOR EXTERNAL SIDE OF UNDERGROUND CARBON STEEL PLANT PIPING AND TANKS

Sl. No.	Design Tempera-- ture in °C	Surface Preparation	Paint System		Total DFT in Microns (min.)	Remarks
			Field Primer	Finish Paint		
13.1	Carbon steel plant piping (underground)					
13.1.1	Yard coating					
13.1.1.1	25 to 60	SSPC-SP-10	1 coat of synthetic fast drying primer type-B as per AWWA-C-203 (1991)	4 mm thick coaltar coating wrapping as per AWWA-C-203 in 2 layers of each 2 mm thickness.	4 mm	CTE coating shall confirm to 120/5 as per BS:4164
13.1.2	Over the Ditch Coating					
13.1.2.1	25 to 60	SSPC-SP-10	1 coat of synthetic fast drying primer type-B as per AWWA-C-203 (1991)	2 layers of coaltar based tape coating as per EIL Standard Spec. No. 6-79-012 Rev.0	4 mm	
13.2	Carbon steel plant piping (underground).					
13.2.1	61 to 400	SSPC-SP-10	1 Coat of F-9 @ 65-75µ DFT/coat	None	65-75	
13.3	External side of un-insulated underground storage tanks:					
13.3.1	-40 to 80	SSPC-SP-10	1 Coat of F-9 @ 65-75µ DFT/coat	3 coats of F-7 @ 100µ DFT/coat 3x100=300	365	
13.3.2	-90 to 41 81 to 400 °C	SSPC-SP-10	1 Coat of F-9 @ 65-75µ DFT/coat	2 coats of F-16 @75 microns DFT/coat = 2x75=150	215-225	

TABLE 14.0 : PAINTING UNDER INSULATION FOR INSULATED (HOT, COLD & SAFETY) CARBON STEEL, LOW ALLOY STEEL, LOW TEMPERTURE CARBON STEEL & STAINLESS STEEL PIPING, STORAGE TANKS AND EQUIPMENTS IN ALL ENVIRONMENT.

Sl. No.	Design Tempera-- ture in ^{o}C	Surface Preparation	Paint system		Total DFT in Microns (min.)	Remarks
			Primer	Finish Paint		
14.1	Insulated carbon steel, low alloy steel and LTCS piping and equipment & tanks					
14.1.1	-45 to 125	SSPC-SP-10	Repair of pre-fabrication primer F-9 @ 65-75µ DFT.	2 coats of F-14 @125µ DFT/coat = 2x125=250 OR 3 coats of F-15= 3x80=240	315	For other temperature ranges no painting is required under insulation
14.1.2	Operating temperature – 45 to 125^{o}C but design temperature 126-400^{o}C	SSPC-SP-10	Repair of pre-fabrication primer F-9 @65-75µ DFT	2 Coats of F-12 @20µ DFT/coat 3x20=60 (or) one coat of Poly-siloxane coating @ 75 microns DFT/coat	125 – 135	F-12 shall be ambient temperature curing type till operating temperature is attained for full curing. F-16 is completely ambient temperature curing.
14.2	Insulated stainless steel including Alloy-20 piping					
14.2.1	Below 0^{o}C to all minus temperatures	Aluminum sheeting with aluminum foil and "Chloride free mineral sealant coating barium chromate" shall be applied.				If the piping & equipments are already erected than surface shall be prepared by cleaning with emery paper and wash/flush with chloride free DM water followed by wiping with organic solvent. No pre-erection primer to be applied. F-12 shall be ambient temperature curing type till final curing is obtained during operating temperature. F-16 is completely ambient temperature curing type. .
14.2.2	0 to 120	SSPC-SP-10 (15-25µ surface profile)	None	2 coats of F-14 @125µ DFT/COAT 2x125=250 or 3 coats of F-15 = 3x80=240	250 or 240	
14.2.3	121 to 400	SSPC-SP-10	None	3 coats of F-12 @20µ DFT/COAT 3x20=60 or 1 coat of F-16 Poly Siloxane coating @ 75 microns DFT/coat	60-75	
14.2.4	401 to 600	SSPC-SP-10		3coats of F-12 @ 20µ DFT/coat 60	60	
14.2.5	Cyclic service-196 to 480 excepting -45 to 120	SSPC-SP-10	None	2 coats of DFT/coat F-16 Poly Siloxane coating @ 75 micronsDFT/coat = 2x75=150	150	
14.3	No painting is required for insulated monel, incoloy and nickel lines.					

TABLE 15.0 : INTERNAL PROTECTION OF CARBON STEEL WATER BOXES AND TUBE SHEETS OF COOLERS / CONDENSERS

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

Sl. No.	Design Temperature in °C	Surface Preparation	Paint system		Total DFT in Microns (min.)	Remarks
			Primer	Finish paint		
15.1	Upto 80	SSPC-SP-10	1 coat of P-6 @ 40µ DFT/coat	2 coats of F-7 @125µ DFT/coat 2x125=250	290	For C.S.
15.2	Upto 80 Non ferrous and brass tube sheets	SSPC-SP-3	1 coat of P-4 @ 8-10µ DFT/coat. 1 coat of P-6 @ 40µ DFT/coat.	2 coats of F-7 @125µ DFT/coat 2x125=250	300	For non ferrous surfaces

TABLE 16.0 : FIELD PAINTING SYSTEM FOR GI TOWERS/NON-FERROUS TUBE SHEET

Sl. No.	Design Temperature in °C	Surface Preparation	Paint System		Total DFT in Microns (min.)	Remarks
			Primer	Finish Paint		
16.1	Upto 80	SSPS-SP-3	1 coat of P-4 @ 8-10µ DFT/coat + 1 coat of P-6 @ 40µ DFT/coat	2 coats of F-2 @40µ DFT/coat 2x40=80	130	Shade as per defence Requirements.
16.2	Upto 80 Non ferrous and brass tube sheets	SSPS-SP-3	1 coat of P-4 @ 8µ DFT/coat. 1 coat of P-6 @ 40µ DFT/coat.	2 coats of F-7 @125µ DFT/coat 2x125=250	300	

17.0 SHOP & FIELD PAINTING SYSTEM FOR EFFLUENT TREATMENT PLANT

Sl. No.	Design Temperature in ^{o}C	Surface Preparation	Paint System		Total DFT in Microns (min.)	Remarks
			Primer	Finish Paint		
17.1	-14 to 80(for C.S./M.S. items): Screens, Walk way bridges, Baffles, Dual media filters(external) Vertical pumps, piping in treated effluent sump and pump house, external side lining of Slop oil MS tank	SSPS-SP-10	1 coat of F-9 @ 65-75µ DFT/coat	3 coats of F-6A @100µ DFT/coat 3x100=300	365	
17.2	-14 to 80(CS/MS Items) for Vertical pump and piping in, Bio-sludge sump and pump, Filter feed sump and pump, Process sump, Sanitary sump; Transfer sump, Sludge, MS Slop oil tank internal, scrapping mechanism in Clarifier, Screw pump	SSPS-SP-10	1 coat of F-9 @ 65-75µ DFT/coat.	2 coats of F-6A @100µ DFT/coat	265	
17.3	-14 to 80 deg.C :All R.C.C. surfaces such as tanks, structures, drains etc.) in Process sump, TPI separator (Process and Oil), Aeration Tank, Transfer sump etc.	Blast cleaning to SSPC-SP guide lines and Acid etching with 10-15% Hcl acid followed by thorough water washing.	As per SMMS-EIL specification for Epoxy screed lining No.6-06-209 (latest Revision)	As per SMMS-EIL specifications for Epoxy screed lining as per 6-06-209 (latest Revision)	3mm	Epoxy screed lining shall be used as per specific instructions from Engineer-in-Charge at site.
17.4	Upto 60 deg. C C.S/M.S Dual media filters (Internal), Chemical dosing tanks(internal such as DAP, Urea	SSPC-SP-10	-	Rubber Lining as per SMMS-EIL Spec. 6-06-204 Rev.4 (Latest revision)	4.5mm	

18.0 STORAGE

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.

19.0 PIPING COLOUR CODE:

The colour code shall be followed as given in Annexure-II.

20.0 IDENTIFICATION OF VESSELS, PIPING ETC.: As per colour coding given in Annexure-II

21.0 PAINTING FOR CIVIL DEFENCE REQUIREMENTS

21.1 Following items shall be painted for camouflaging if required by the client.

a. All columns
b. All tanks in off sites
c. Large Vessels
d. Spheres

21.2 Two coats of selected finishing paint as per defence requirement shall be applied in a particular pattern as per 20.3 and as per the instructions of Engineer-In-Charge.

21.3 **Method of Camouflaging**

21.3.1 Disruptive painting for camouflaging shall be done in three colours in the ratio of 5:3:2 (all matt finish).

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

21.3.2 The patches should be asymetrical and irregular.

21.3.3 The patches should be inclined at 30 Deg.. to 60 Deg. to the horizontal.
21.3.4 The patches should be continuous where two surfaces meet at an angle.
21.3.5 The patches should not coincide with corners.
21.3.6 Slits and holes shall be painted in dark shades.
21.3.7 Width of patches should be 1 to 2 meters.

22.0 INSPECTION AND TESTING

22.1 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.

22.2 Engineer-In-Charge at his discretion, may call for tests for paint formulations. Contractor shall arrange to have such tests performed including batch-wise test of wet paints for physical & chemical analysis. All costs there shall be borne by the contractor.

22.3 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

In addition to above, record should include type of shop primer already applied on equipment e.g. Red oxide zinc chromate or zinc chromate or Red lead primer etc.

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 (D F T)) 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 cost should have prior approval of Engineer-in-charge.

22.4 **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.

22.5 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.

22.6 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 and protector whenever required for checking in case of immersion conditions.

22.7 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 'Elkometer'. 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.

22.8 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.

22.9 Final inspection shall include measurement of paint dry film thickness, Adhesion, Holiday detection check of finish and workmanship. The thickness should be measured at as many points/ locations as decided by Engineer-In-Charge and shall be within + 10% of the dry film thickness, specified in the specifications.

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

23.0 GUARANTEE

23.1 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.

23.2 The contractor shall produce test reports from manufacturer regarding the quality of the particular batch of paint supplied. The Engineer-in-Charge shall have the right to test wet samples of paint at random for quality of same, as per the paint materials specification. Batch test reports of the manufacturer's for each batch of paints supplied shall be made available by the contractor. The contractor shall stand guarantee for carrying out the rectification/repair/re-painting of the defects/ failures of painting found during the execution of painting job and till the expiry of the defect liability period of total project as per the directions of the Engineer-in-Charge of B0RL/EIL.

24.0 QUALIFICATION CRITERIA OF PAINTING CONTRACTOR

Painting contractor who is awarded the job under this standard must have necessary equipments, machinery, tools and tackles for surface preparation, paint application and inspection. The contractor mush have qualified, trained and experienced surface preparator, paint applicator, inspector and supervisors. The contractor's supervisor, inspector, surface preparator and paint applicator must be conversant with the standards referred in this specification. The painting job shall be carried out by the approved agencies of paint manufacturers and supervised by the approved paint manufacturers own representative or paint manufacturer their scheme(supply and apply basis).

ANNEXURE-I

LIST OF RECOMMENDED MANUFACTURERS

Indian Vendors

1. Asian Paints (I) Ltd., Mumbai
2. Berger Paints Ltd., Kolkata
3. Goodlass Nerolac Paints Ltd., Mumbai
4. Chemguard Coatings, Mumbai(For Ameron, USA Products only)
5. Chokugu Marine paints Pte. Ltd., Mumbai/Singapore
6. Shalimar Paints Ltd., Kolkata
7. Sigma Coatings, Mumbai.
8. CDC Carboline Ltd., Chennai
9. Premier products Ltd., Mumbai
10. Coromandel Paints & Chemicals Ltd., Visakhapatnam
11. Anupam Enterprises, Kolkata
12. Grand Polycoats, Vadodata
13. Bombay Paints Ltd., Mumbai
14. Paladin Paints and Chemicals, Mumbai
15. Akzo Nobel Coatings and Sealants Pvt. Ltd., Bangalore
16. Cipy Polyurethanes Pvt. Ltd., Pune
17. Gunjan Paints Ltd., Ahmedabad
18. Advance Paints Ltd., Mumbai
19. VCM Polyurethane Paints (for polyurethane paints only)
20. Jotun Paints, Chennai(Singapore)
21. Chembond Chemicals Ltd., Navi Mumbai

Foreign Vendors

1. Sigma Coatings, Singapore
2. Ameron, USA
3. Kansai Paints, Japan
4. Hempel Paints, USA
5. Valspar Corporation, USA
6. Akzo Nobel/International Coatings, UK
7. Jotun Paints, Singapore

The following are approved vendors for speciality items (phosphating chemical) only.

1.0 Mark-chem Incorporated, Mumbai .
2.0 Chemtreat India Ltd., Navi Mumbai

Annexure-II to Specification No.6743-31-0642-PT-C06 Rev.0

Paint Colour Code for Piping and Equipment:

1.0 SCOPE

This specification covers the requirement of colour scheme for the identification of the contents of the pipelines carrying fluids, storage tanks and equipment in refineries and petrochemical installations. The following colour coding system has been made based on international standards like ASME/ ANSI, BS and Indian Standard.

2.0 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.

2.1 The following ground colour designation for identification of basic 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	-	Crude oil, lube oil
Orange	-	Volatile petroleum products (motor spirit 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

2.2 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.

3.0 COLOUR BANDS AND IDENTIFICATION LETTERING

3.1 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 50 mm wide and regardless of band width, are spaced 25 mm apart when two bands are employed

Table 1.0: 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 band 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.

3.2 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.

3.3 For piping, writing of name of service and direction of flow for all the lines shall be done at following locations:

3.4 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.

3.5 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.

3.6 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.

4 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

5 In case of camouflaging requirements of civil defence or any other locational requirements, the same shall be followed accordingly.

6 The specification for application of the complete Piping identification colour code, including base and bands colours, are presented in the enclosed table

IOCL RECOMMENDED PAINT COLOUR CODE

SI. NO.	SERVICE	RECOMMENDED COLOUR CODE	COLOUR
	HYDROCARBON LINES (UNINSULATED)		
1.	CRUDE SOUR	Dark Ad. Grey with 1 orange band	
2.	CRUDE SWEET	Dark Ad. Grey with 1 red band	
3.	LUBE OILS	Dark admiralty grey with 1 green band	
4.	FLARE LINE	Heat resistant Aluminium	
5.	L.P.G.	Orange with 1 oxide red	
6.	PROPYLENE	Orange with 2 oxford blue band	
7.	NAPHTHA	Orange with 1 green band	
8.	M.S.	Orange with 1 dark ad. grey	
9.	AV. GASOLINE (96 RON)	Orange with 1 band each of green, white & red bands	
10.	GASOLINE (regular, leaded)	Orange with 1 black band	
11.	GASOLINE (Premium, leaded)	Orange with 1 blue band	
12.	GASOLINE (White)	Orange with 1 white band	
13.	GASOLINE (Aviation 100/130)	Orange with 1 red band	

SI. NO.	SERVICE	RECOMMENDED COLOUR CODE	COLOUR
14.	GASOLINE (Aviation 115/145)	Orange with 1 purple band	
15.	N-PENTANE	Orange with 2 blue bands	
16.	DIESEL OIL (White)	Oxide red with 1 white band	
17.	DIESEL OIL (Black)	Oxide red with 1 yellow band	
18.	KEROSENE	Oxide red with 1 green band	
19.	HY.KERO	Oxide red with 2 green bands	
20.	DISULFIDE OIL (EX-MEROX)	Oxide red with 1 black band	
21.	M.T.O.	Oxide red with 3 green bands	
22.	DHPPA	Oxide red with 2 white bands	
23.	FLUSHING OIL	Oxide red with 2 black bands	
24.	LAB FS	Oxide red with 2 dark Ad. Grey	
25.	LAB RS	Oxide red with 3 dark Ad. Grey	
26.	LAB (Off. Spec.)	Oxide red with 1 light grey	
27.	N-PARAFFIN	Oxide red with 1 blue band	
28.	HEAVY ALKYLATE	Oxide red with 1 red band	
29.	BLOW DOWN, VAPOUR LINE	Off White / Aluminium with 1-Brown band	

SI. NO.	SERVICE	RECOMMENDED COLOUR CODE	COLOUR
30.	BLOW DOWN	Off White / Aluminium with 2 brown bands	
31.	A.T.F.	Leaf brown with 1 white band	
32.	TOULENE	Leaf brown with 1 yellow band	
33.	BENZENE	Leaf brown with 1 green band	
34.	LAB PRODUCT	Leaf brown with 1 blue band	
35.	FUEL OIL	Black with 1 yellow band	
36.	FUEL OIL (aromatic rich)	Black with 2 yellow bands	
37.	ASPHALT	Black with 1 white band	
38.	SLOP & WASTE OILS	Black with 1 orange band	
39.	SLOP AROMATIC	Black with 2 orange bands	
	CHEMICAL LINES (UNINSULATED)		
40.	TRI-SODIUM PHOSPHATE	Canary yellow with 1 violet band	
41.	CAUSTIC SODA	Canary yellow with 1 black band	
42.	SODIUM CHLORIDE	Canary yellow with 1 white band	
43.	AMMONIA	Canary yellow with 1 blue band	

SI. NO.	SERVICE	RECOMMENDED COLOUR CODE	COLOUR
44.	CORROSION INHIBITOR	Canary yellow with 1 Aluminium band	
45.	HEXAMETA PHOSPHATE	Canary yellow with 2 black band	
46.	ACID LINES	Golden yellow with 1 red band	
47.	RICH AMINE	Canary yellow with 2 blue bands	
48.	LEAN AMINE	Canary yellow with 3 blue bands	
49.	SOLVENT	Canary yellow with 1 green band	
50.	LCS	Canary yellow with 1 smoke grey	
	WATER LINES (UNINSULATED)		
51.	RAW WATER	Sky blue with 1 black band	
52.	INDUSTRIAL WATER	Sky blue with 2 signal red bands	
53.	TREATED WATER	Sky blue with 1 oxide red band	
54.	DRINKING WATER	Sky blue with 1 green band	
55.	COOLING WATER	Sky blue with 1 light brown band	
56.	SERVICE WATER	Sky blue with 1 signal red band	
57.	TEMPERED WATER	Sky blue with 2 green bands	

SI. NO.	SERVICE	RECOMMENDED COLOUR CODE	COLOUR
58.	DM WATER	Sky blue with 1 Aluminium band	
59.	DM WATER ABOVE 150 °F	Sky blue with 2 black bands	
60.	SOUR WATER	Sky blue with 2 yellow bands	
61.	STRIPPED WATER	Sky blue with 2 blue bands	
62.	ETP TREATED WATER	Sky blue with 2 oxide red bands	
	FIRE PROTECTION SYSTEM (ABOVE GROUND)		
63.	FIRE WATER, FOAM & EXTINGUISHERS	Post office red	
	AIR & OTHER GAS LINES (UNINSULATED)		
64.	SERVICE AIR	Sea green with 1 signal red band	
65.	INSTRUMENT AIR	Sea green with 1 black band	
66.	NITROGEN	Sea green with 1 orange band	
67.	FREON	Sea green with 1 yellow band	
68.	CHLORINE	Canary yellow with 1 oxide red band	
69.	SO_2	Canary yellow with 2 white band	

Sl. NO.	SERVICE	RECOMMENDED COLOUR CODE	COLOUR
70.	H_2S	Orange with 2 red oxide bands	
71.	Gas (Fuel)	Orange with 1 Aluminium band	
72.	GAS (Sour)	Orange with 2 Aluminium band	
73.	GAS (Sweet)	Orange with 2 signal red band	
74.	HYDROGEN	Orange with 1 light green band	
	STEAM & CONDENSATE LINES (UNINSULATED)		
75.	HP STEAM	Off white / Aluminium with 1 yellow band	
76.	MP STEAM	Off white / Aluminium with 1 red band	
77.	MLP STEAM	Off white / Aluminium with 1 orange band	
78.	LP STEAM	Off white / Aluminium with 1 green band	
79.	CONDENSATE	Sky blue with 1 white band	
80.	CONDENSATE ABOVE 150 ^{0}F	Sky blue with 3 oxide red bands	
81.	BFW	Sky blue with 2 gulf red bands	
	Note: For all insulated steam lines, the colour coding shall be followed as given for uninsulated lines with the specified length of colour bands.		

SI. NO.	SERVICE	RECOMMENDED COLOUR CODE	COLOUR
	INSULATED HYDROCARBON PIPING		
82.	IFO SUPPLY	1 black ground colour with 1 yellow band in centre	
83.	IFO RETURN	1 black ground colour with 1 green band in centre	
84.	HPS	1 black ground colour with 1 red band in centre	
85.	BITUMEN	1 black ground colour with 2 red band in centre	
86.	CLO	1 black ground colour with 1 brown band in centre	
87.	VB TAR	1 black ground colour with 2 brown band in centre	
88.	VR AM (BITUMEN / VBU FEED)	1 black ground colour with 1 blue band in centre	
89.	VR BH	1 black ground colour with 2 blue band in centre	
90.	VAC. SLOP	1 black ground colour with 1 white band in centre	
91.	SLOP	1 black ground colour with 1 orange band in centre	
92.	CRUDE SWEET	1 dark admiralty grey ground colour with 1 red band in centre	
93.	CRUDE SOUR	1 dark admiralty grey ground colour with 1 orange band in centre	
94.	VGO / HCU FEED	1 oxide red ground colour with 1 steel grey band in centre	
95.	OHCU BOTTOM / FCCU FEED	1 oxide red ground colour with 2 steel grey band in centre	

Sl. NO.	SERVICE	RECOMMENDED COLOUR CODE	COLOUR
	UNINSULATED EQUIPMENT, TANKS & STRUCTURES		
96.	HEATER STRUCTURE	Steel grey	
97.	HEATER CASING	Heat resisting Aluminium	
98.	VESSELS & COLUMNS	Aluminium	
99.	HYDROGEN BULLETS	Pink	
100.	LPG VESSELS	Red Oxide	
101.	SO_2 VESSEL	Canary Yellow	
102.	HEAT EXCHANGERS	Heat resisting Aluminium	
103.	FO TANK & HOT TANKS	Black	
104.	ALL OTHER TANKS	Aluminium / off white	
105.	CAUSTIC / AMINE / ACID TANKS	Golden Yellow	
106.	SOUR WATER	Sky Blue	
107.	OUTER SURFACE IN BOILER HOUSE	Heat resisting Aluminium	
108.	COMPRESSORS & BLOWERS	Dark Admiralty Grey	
109.	PUMPS	Navy Blue	
110.	MOTORS & SWITCH GEAR	Bluish Green	

Sl. NO.	SERVICE	RECOMMENDED COLOUR CODE	COLOUR
111.	HAND RAILING	Signal Red	
112.	STAIRCASE, LADDER & WALKWAYS	Black	
113.	LOAD LIFTING EQUIPMENT & MONO RAILS ETC.	Leaf Brown	
114.	GENERAL STRUCTURE	Black	
	PIPES & FITTINGS OF ALLOY STEEL & SS MATERIAL IN STORES (REFER ARTICLE 5.0)		
115.	IBR	Signal red	
116.	9Cr - 1Mo	Verdigris green	
117.	5Cr - ½Mo	Satin blue	
118.	2¼ Cr - 1Mo	Aircraft yellow	
119.	1¼Cr - ½Mo	Traffic yellow	
120.	SS-304	Dark blue grey	
121.	SS-316	Dark violet	
122.	SS- 321	Navy blue	
	SAFETY COLOUR SCHEMES		
123.	DANGEROUS OBSTRUCTION	Black & alert orange bands	

Sl. NO.	SERVICE	RECOMMENDED COLOUR CODE	COLOUR
124.	DANGEROUS OR EXPOSED PARTS OF MACHINERY	Alert orange	

Painting for Civil Defence requirements:

(i) The following items shall be painted for camouflaging, as per specific site requirement of Defence.

a) All columns
b) All tanks in offsites
c) Large vessels
d) Spheres

(ii) Two coats of selected finish paint as per defence requirement shall be applied in a particular pattern as per (iii) and as per the instructions of the Engineer-in-Charge.

(iii) Method of camouflaging:

a) Disruptive painting for camouflaging shall be done in three colours in the ratio of 5:3:2 (all matt finish)

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

b) The patches should be asymmetrical and irregular.
c) The patches should be inclined at 30^0C to 60^0C to the horizontal.
d) The patches should be continuous where two surfaces meet at an angle and the patches should be coincide with corners.
e) Slits and holes shall be painted in dark shades.
f) Width of patches should be 1 to 2 meters.