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1. INTRODUCTION

INDIAN OIL CORPORATION LIMITED (IOCL) has awarded Fax of Acceptance (FOA) dated 29th August 2019 to M/s. Technip India Limited (TPIL) for Consultancy services (PMC/EPCM services) for overall project management, FEED Review / FEED, Detailed Engineering, Procurement & expediting services, Tendering & award, Construction Management & Supervision, Assistance in start-up, Commissioning & performance test runs for installation of a Standby SRU of 525 TPD capacity and execution of Additional tanks for Paradip Refinery, Odisha, India.

2. DEFINITIONS & ABBREVIATIONS

Abbreviation	Definition /Expanded form
IOCL/ CLIENT	Indian Oil Corporation Limited
PMC/ CONSULTANT	Technip India Limited
LICENSOR	Party selected by IOCL for process technology ownership for any UNIT
CONTRACTOR	Party whose services are obtained for performing the works specified as part of LSTK / packages.
EPCM	Engineering, Procurement & Construction Management Services.
LSTK	Lump Sum Turn Key portion of the work to be executed by CONTRACTOR
FEED	Front End Engineering Design
AUTHORISED REPRESENTATIVE	IOCL's/ CONSULTANT's representative authorized to act for and on behalf of them.
VENDOR	Any third party supplying the equipment/materials for setting up the Plant
PROJECT	Indicates Standby SRU and Additional tanks Project, Paradip Refinery
UNIT	Indicates any particular portion of the project to be built which can be Process related or Utilities/Offsites related

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SRU	Sulphur Recovery Unit
OISD	Oil Industry Safety Directorate
ASME	American Society of Mechanical Engineers
API	American Petroleum Institute
P&ID	Piping and Instrumentation Diagram
A/G	Above Ground
U/G	Under Ground
B/L	Battery Limit
ISBL	Inside Battery Limit
EOT	Electrically-operated Overhead Travelling
MTO	Material Take Off


3. **SCOPE**

This specification defines the requirements of surface preparation, selection and application of paints and primers for all piping, equipment and structures etc.

The specification is applicable for supply of all paints, coatings, primers and other ancillary items etc. Method of surface preparation, supply and application of paints and primers shall suit given environment, location and temperature. Items requiring painting, field application procedures, inspection and testing of painting shall be governed by this specification.

This specification is suitable for use in normal, corrosive and marine environment of various process, utility and other plants and offsite of refineries, petro-chemicals, onshore terminals and other chemical / industrial plants. Alternative paints / coatings would be specified if necessary for specific or more stringent requirements.

The painting specification covers every type of equipment such as tanks, vessels, drums, heat exchangers/ coolers, air fin coolers, pumps, turbines, compressors, filters, engines, motors, boilers or heaters /furnaces their accessories, fans, stacks / chimney and package units etc.

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The painting specification covers all types of process and utility piping services which can be non-insulated / insulated, jacketed or lined requiring painting. All types of pipe supports, hangers, spring boxes are also covered.

All types of structural steel members, platforms ladders, chequered plates, gratings, walkways, trolleys, monorails, davits, structural steel sheds and buildings are also covered under this painting specification.

The painting of equipment shall conform to equipment data sheets. Painting of piping shall conform to line schedule and piping isometrics etc.


4. **TERMINOLOGY**

MR	Material Requisition
PR	Purchase Requisition
PO	Purchase Order
CS	Carbon steel
LTCS	Low Temp. Carbon Steel
AS	Alloy Steel
SS	Stainless steel
MS	Mild Steel
GI.	Galvanized Iron / steel
ITP	Inspection Test Plan
TPI	Third Party Inspection
DFT	Dry Film Thickness
WFT	Wet Film Thickness
TSAC	Thermally Sprayed Aluminium Coating
Micr.	Micron

5. **EXCLUSIONS**

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 specifications:

- Plastics and or plastic coated surfaces
- Non-ferrous materials like Aluminum, Cu-Ni alloy, Monel, Incoloy
- RCC or cement lined surfaces except those specified
- Gaskets / seals

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- Gauge Glasses
- Meter Faces
- Valve Stem and Threads
- Name Plates
- Insulation or Fireproofing
- Factory Finished Control Panels
- Factory Finished Instrument Cases and Meters

6. REFERENCE CODES & STANDARDS

The following codes shall be applicable, however purchaser may specify any other relevant code for any purpose at any time. The codes latest edition as on date of issue of material requisition shall be applicable.

Code /Std. No	Description
IS: 5	Colours for ready mixed paints and enamels
IS: 101	Methods of test for ready mixed paints and enamels
IS: 2379	Indian Standard for Pipe line identification-colour code
ISO 209	Aluminium and aluminium alloys Chemical composition
ISO 8501-01	Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness
ISO 8502-3 & 9	Preparation of steel substrates before application of paints and related products - Test for assessment of surface cleanliness : Field method for conductometric determination of water soluble salts
ISO12944	Corrosion Protection of steel Structures by Protective Paint System
ASTM E3	Metallographic Examinations
ASTM VOL 6.01 & 6.03	American standard test methods for Paints and Coatings.
ASTM B833	Standard Specification for Zinc and Zinc Alloy Wire for Thermal Spraying (Metallizing) for the Corrosion Protection of Steel , corrosion protection
ASTM C633	Test Method for Adhesive / Cohesive Strength of Flame Sprayed Coatings.

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ASTM D4285	Method for indicating Oil or Water in Compressed Air.
ASTM D4417	Test Method for Field Measurement of Surface Profile of Blasted Steel.
ASTM D4541	Test method for Pull-Off Strength of Coating using Portable Adhesion Testers.
ASTM D4940	Standard Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blasting Abrasives.
ASTM D6677	Standard Test Method for Evaluating Adhesion by Knife1
ANSI A13.1	Scheme for identification of piping systems: American National Standards Institution
ANSI/AWS C2.18	Guide for the Protection of Steel with Thermal Spray Coatings of Aluminium, Zinc and Their Alloys and Composites.
AWS C.2.17	Recommended Practice for Electric Arc Spray.
SSPC-SP	Steel Structures Painting Council
SSPC Publication	The inspection of coatings and linings: A Handbook of Basic practice for Inspectors, Owners, and Specifiers.
SSPC-AB 1	Mineral and Slag Abrasives.
SSPC-AB 3	Ferrous Metallic Abrasives.
SSPC-PA 1	Shop, Field, and Maintenance Painting of Steel.
SSPC-PA 2	Measurement of Dry Coating Thickness with Magnetic Gages.
NACE No. 1 / SSPC-SP 5	White Metal Blast Cleaning.
NACE No. 2 / SSPC-SP 10	Near -White Metal Blast Cleaning.
SSPC-VIS 1	Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning.
RAL DUTCH	International Standard for color shade (Dutch Standard)
SIS-05 59 00	Pictorial surface preparation standard for painting of steel surfaces
BS1475	Specification for Wrought Aluminium & Aluminium Alloys for General Engineering Purposes.
BS 2569	Specification for Sprayed Metal Coating.
BS 4232	British Standards (Surface Finish of Blast-cleaned Steel for Painting
NACE Std. RP 0287	Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using a Replica Tape.

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NACE No.12 / AWS C2.23 M / SSPC-CS 23.00	Specification for the application of thermal spray coatings (Metallizing) of aluminium, zinc, and their alloys and composites for the corrosion protection of steel.
NACE RP 198	The control of corrosion under Thermal Insulation and Fireproofing Materials

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.

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

The Contractor shall perform the work in accordance with the following reference documents issued to him for execution of painting works.

- Bill of quantities for piping, equipment, machinery and structures etc
- Piping Line List
- Specifications for Painting
- Any Specific requirements from client

7. GENERAL REQUIREMENTS

- This specification shall govern all works covered by the contract, and without prejudice to the provisions of various Indian and international codes of practice, standard specifications etc. The Contractor shall carry out the works in all respects with the best quality of materials and workmanship and in accordance with the best engineering practices and instructions of Owner / Engineer in charge.
- All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning and all equipment, scaffolding materials, shot / sand blasting equipment and 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 compressed air supply used for blasting shall be free of water and oil. Adequate separators and traps shall be provided and these shall be drained continuously. Pressure Gauges fitted to compressor shall be calibrated with necessary certificate.
- Blast cleaning equipment shall be in accordance with all applicable regulations. The spraying equipment to be used shall meet the recommendations and instructions set forth by the paint supplier for each specific paint or coating system.
- All mechanical equipment shall be earthed and all necessary precautions shall be taken to prevent the build-up of static electricity. Especially blasting equipment, its operators and the equipment being blasted shall be properly earthed to prevent the occurrence of electro-

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static discharges


- 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.
- All painting materials and ancillary materials needed for completion of the contract shall conform to the prescribed specifications. Contractor shall procure these materials from specified manufacturers or their stockiest with proper marking and identification as proof of original materials.
- Any sub-standard or duplicate materials or lower grade/ brand materials shall not be used. Owner / Engineer in charge shall have the right to reject all such materials at any stage. Contractor shall seek prior approval from Owner before actual application to avoid rejection of works carried out with such sub-standard materials.
- The Contractor shall bring to the notice of Owner any discrepancy between this specification and codes specified herein. Contractor may request Owner for clarification of any of the applicable clause of this specification or about applicability of a particular painting system for any service / surface. Any deviation from this specification pertaining to supply or application without written permission of Owner shall be rejected by Engineer in charge.
- The items listed in the paint systems is indicative only, however Engineer in charge may decide about the applicability of the paint system for any of the works.
- The Contractor shall ensure all safety and protective apparatus are fully provided to their staffs.
- The contractor shall be fully responsible for carrying out all the necessary painting, coating and lining on external and internal surfaces as per the tender requirement.
- 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:
 - Instructions for storage to avoid exposure as well as extremes of temperature.
 - Surface preparation prior to painting shall be followed as per the specification.
 - Mixing and thinning.
- 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 general characteristics described in various tables.
- Contractor shall fully comply with the client specification for Colour Coding of Piping, Equipment and Structures issued during EPC stage of the project. This specification covers colour codes, identification marking on piping and equipment, recommended colours for paint systems and painting for "Civil Defence" requirements etc.
- Contractor shall ensure that the paint material supplied are fully within the validity period of the product and not exposed to open atmosphere.

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8. EXTENT OF PAINTING

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

- All Non-insulated carbon steel and alloy steel piping as described under scope Including valves, flanges, fittings, specialty items, in line items, and all supports (including painting of identification marks), flare lines ,furnace ducts and stacks.
- Titanium catalyzed inorganic copolymer can be used commonly for all valves.
- All insulated parts of vessels, boilers, chimneys, stacks, piping and steam piping, and any other insulated items present.
- All items contained in a package unit requiring painting.
- All types of structural steel members, platforms ladders, chequered plates, gratings, walkways, trolleys, monorails, davits, structural steel sheds and buildings are also covered under this painting specification.
- External surfaces of MS chimney with or without refractory lining and internal surfaces of MS chimney without refractory lining. (If present)
- Representation of colour bands on all piping including insulated aluminum clad, galvanized, SS and nonferrous piping.
- Identification lettering / numbering on all painted surfaces of equipment / piping insulated aluminum 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)
- Metal Area over which insulation surface of equipment and pipes wherever required.
- Painting under insulation for carbon steel, alloy steel and stainless steel as per relevant NACE RP 198 to prevent corrosion.
- 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.

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- All CS Piping, equipment, 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).

9. SURFACE PREPARATION

Any one of following methods of surface preparation shall be followed, depending on condition of surface to be painted and as approved or instructed by Engineer in charge.



- Manual or hand tool cleaning
- Mechanical or power tool cleaning
- Dry abrasive blast cleaning

Before blasting salt contamination test to be carried out for metals & Testing for chloride and soluble salt concentrations and the pH level shall be done using a Bresle Sampler according to ISO 8502-6. The chloride and soluble salt concentrations shall be less than 20 mg/ m² and the pH shall be neutral (between 6 and 8). When these levels are exceeded, the surfaces shall be either steam cleaned or high pressure water washed as per SSPC SP1 or ISO 12944 before abrasive blasting. The cleaned surface shall be retested to verify that the contaminant levels are within the acceptable range. Checks shall be done on each component at least once per 200 m² of blasted surface and a minimum of 3 checks per shift. The test report shall be maintained recording the ambient and substrate temperature, relative humidity, abrasive medium, test obtained values etc., Measuring device shall be regularly calibrated.

9.1 Surface Finish Requirements:

- When surface is exposed to normal atmospheric conditions and where other methods cannot be adopted. May also be used for spot cleaning during maintenance.
 - Solvent Cleaning to SSPC - SP1. Remove oil, grease or wax with a suitable solvent/degreaser (Non-Chloride solvent to be used on SS substrate)
 - Manual or hand tool cleaning to: SSPC-SP-2 or ST.2 Level

Remove loose rust / mill scale / loose paint thoroughly by chipping, scrapping, sanding and or wire brushing. Finished surface shall have a faint metallic

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sheen.

- Mechanical or power tool cleaning to SSPC-SP-3 or ST.3 Level

Remove loose rust / mill scale / 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.

Care to be taken where the welding / riveting portion of the joints.

- **Dry abrasive Blast cleaning:**

There are four different methods of dry abrasive blast cleaning as described below. Each method shall be selected depending on surface finish required for particular paint system. However Engineer in charge may instruct about any of the system to be followed for a particular job / item as deem necessary.

- White metal to SSPC-SP-5 or SA.3 or NACE #1 Level

Remove all visible rust / Mill scale / paint and foreign matter 100% to achieve desired surface profile with blast cleaning to white metal cleanliness in order to achieve extremely clean surface for prolonged life of paint system.

- Near white metal to SSPC-SP-10 or SA.2 ½ or NACE # 2 Level



Blast clean 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 in order to have minimum acceptable clean surface. This is 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.

- Commercial Blast to SSPC-SP-7 or SA.2 or NACE # 3 Level

Blast clean until at least two-third of each element of surface area is free of all visible residues with desired surface profile. Used for steel required to be painted with conventional paints for exposure to mildly corrosive atmosphere for longer life of the paint systems.

- Brush-off Blast to SSPC-SP-7 or SA.1 or NACE # 4 Level

Blast cleaning to white metal cleanliness, removal of all visible rust, mill scale, paint and foreign matter where surface profile is not so important


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9.2 Equipment surface Preparation:

- All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning and all equipment, scaffolding materials, shot & grit blasting equipment and 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.
- 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.
- 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 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 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.


9.3 Use of Dehumidifiers:

- Blast cleaning shall not be performed for internal or external surface, 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, enough to maintain it 3°C below the metal substrate temperature during entire 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,

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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 shall 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.
- 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.
- 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 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 recleaning, 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.
- The external surface of R.C.C. chimney stack 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.

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9.4 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 7 kg/cm² 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 G 16 - 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.

9.5 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.


9.6 Non-Compatible Shop Coat Primer:

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- For equipment 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. Specific duration mentioned in the manufacturer specification shall be fully If the shop coat is in satisfactory condition showing no major defect upon arrival at site, the shop coat shall not be removed.
- Shop coated equipment (coated with Primer & finishing coat) should not be repainted unless paint is damaged. Repair shall be carried out as per **Table 10.2** of paint systems depending upon compatibility of paint.
- 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.
- 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.
- Coating application at field (field primer, intermediate and top coat) on equipment, structures, piping, etc. shall be carried out only after its erection and all welding, testing, steam purging (wherever carried out) have been completed.

10. **COATING PROCEDURE & 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 manufacture's recommendation should be followed before deciding for brush application.

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- 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 20 km per hour.
- Blast cleaned surface shall be coated with one complete application of primer as soon as practicable but in no case later than 4 hours the same day.
- 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.
- 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.
- 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.
- Airless spray application shall be in accordance with the following procedure: as per steel structure paint Manual Vo. 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.

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- 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.
- Brush application of paint shall be in accordance with the following:
 - Brushes shall be of a style and quality that will enable proper application of paint.
 - 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.
 - Paint shall be applied into all corners.
 - Any runs or sags shall be brushed out.
 - There shall be a minimum of brush marks left in the applied paint
 - Surfaces not accessible to brushes shall be painted by spray, doublers, or sheepkin.
- 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.
- 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.
- 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.
- No drier shall be added to paint on the job unless specifically called for in the manufacturer's specification for the paint.

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

11. SURFACE PREPARATION METHOD


The table below describes the methods for surface preparation and the standards used for cleanliness and surface preparation for painting /coating works.

SURFACE PREPARATION

Sr. No.	Description	International Standards (Equivalent)			Remarks
		ISO 8501-1 / SIS-05 59 00	SSPC-SP, USA	NACE, USA	
1.	- Solvent Cleaning Remove oil, grease or wax with a suitable solvent/degreaser (Non-Chloride solvent to be used on SS substrate)	ST-1	SSPC - SP1		
2.	Manual or hand tool cleaning: Removal of loose rust, loose mill scale and loose paint, chipping, scrapping, standing and wire brushing. Surface shall 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.
3.	Mechanical or power tool cleaning: Removal of loose rust loose mill scale and loose paint to by power tool chipping, de-scaling, sanding, wire brushing and grinding, after removal of dust, surface shall have a pronounced	ST.3	SSPC-SP-3	-	

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	metallic sheen.				
4	Dry abrasive Blast cleaning: There are four common grades of blast cleaning White metal				
4.1	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.
4.2	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 2 ½	SSPC-SP-10	NACE #2	For chemically resistant paint systems such as epoxy, vinyl, polyurethane based and inorganic zinc silicate paints, and for paint systems used under fairly corrosive conditions to obtain desired life of paint system.
4.3	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.
4.4	Brush-off Blast: Blast cleaning to white metal cleanliness, removal of all visible rust, mill scale, and paint foreign matter. Surface profile is not so important	SA 1	SSPC-SP-7	NO. 4	



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12. PAINTING / COATING MATERIALS

12.1 List of Primers and Finish Paints used:

A broad list of primers and finish paints to be used for painting and coating works is as given below:

PRIMERS	
PR-1	Chlorinated Rubber Zinc Phosphate Primer
PR-2	Etch Primer / Wash Primer
PR-3	Two component Epoxy Zinc Phosphate Primer cured with polyamine hardener
PR-4	Single pack, cold galvanizing compounds containing minimum 92% Electrolytic Zinc in dry film. make ZINGA, LOCKTITE (of HENKEL) or ZRC
FINISH COATS / PAINTS	
FP-1	Two component Acrylic – Polyurethane finish paint
FP-2	Chlorinated Rubber finish paint
FP-3A	High Build Epoxy finish coating cured with polyamine hardener
FP-3B	High Build Epoxy finish coating cured with polyamide hardener
FP-3C	Solvent less Epoxy Coating cured with polyamine hardener
FP-4	High build Coal Tar Epoxy coating cured with polyamine hardener
FP-5	Self-priming surface Tolerant High Build Epoxy coating. cured with polyamine hardener
FP-6	Two component Inorganic Zinc Silicate coating
FP-7	Heat resistant synthetic medium based Aluminium paint
FP-8	Two component Heat resistant Silicone Aluminium paint.
FP-9	Specially formulated Coal Tar Epoxy coating. cured with polyamine hardener
FP-10	Two component Epoxy Phenolic coating cured with Polyamine adduct hardener system
FP-11	Engineered Epoxy Poly Siloxane Coating or High Build cold applied inorganic Co-polymer based Aluminium coating
FP-12	Two component solvent free type High Build Epoxy Phenolic / Novalac Epoxy Phenolic coating cured with Polyamine adduct hardener system



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12.2 Detailed Specification of Primers and Finish Paints

The following are the various parameters of primers, finish paints and coating materials to be used for carrying out various painting / coating works


PRIMERS

Sr. No.	Description	PR-1	PR-2	PR-3	PR-4
1.	Technical Name	Chlorinated Rubber Zinc Phosphate Primer	Etch Primer / Wash Primer	Epoxy Zinc Phosphate Primer	Zinga, Locktite or ZRC Cold Galvanized
2.	Pack Type	Single Pack	Two Pack	Two Pack	Single Pack
3	Composition	Air Drying Chlorinated, Rubber based medium Plasticized with unsaponifiable Plasticizer, pigmented with zinc phosphate	Polyvinyl butyral resin medium cured with phosphoric acid solution. pigmented with zinc tetroxy chromate	Polyamine cured epoxy resin, medium, pigmented with zinc phosphate	Synthetic resin based zinc galvanizing containing min 92% of electrolytic zinc dust of 99.95% purity.
4.	Vol. Solids %	40±3	10±1	50±1	37%
5.	DFT (Micron) / Coat	40-45	8-10	40-50	40-50fl
6.	Covering M ² / Coat / Litre	8-10	8-10	8-10	4 m ² /kg
7.	Wt. Kg. / Litre	1.3±0.05	1.2±0.05	1.4±0.05	2.67 kg at 15°C
8.	Touch Dry at 30°C Min.	30 minutes	2hrs.	After 30 min.	10 minutes
9.	Hard Dry at 30°C Max.	8 hrs.	24 hrs.	8 hrs.	24 hrs.
11.	Over-coat Interval at 30°C	Min.: 8 hrs.	Min.: 4-6 hrs.	Min.:8hrs.	Min.:4 hrs
12.	Pot Life at 30°C	Not applicable	Not applicable	6-8 hrs.	Unlimited
13.	Temperature. Resistance min	60°C Dry service	NA Dry service	80°C Dry service	50°C Dry service

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FINISH PAINTS

Sr. No.	Description	FP-1	FP-2	FP-3A /B	FP-3C	FP-4
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 coat.
2.	Pack Type	Two pack	Single pack	FP-3A: Two pack	Two pack	Two pack
3.	Composition	Aliphatic isocyanate cured acrylic finish paint with Glossy-High Glossy finish	Plasticized chlorinated rubber based medium with chemical and weather resistant pigments.	FP-3A: Aromatic amine cured epoxy resin medium suitably pigmented. FP-3B: polyamide cured epoxy resin medium suitably pigmented	Cured with Amine Adduct; catalyzed epoxy resin suitably pigmented.	Polyamide cured epoxy resin blended with coaltar medium, suitably pigmented
4.	Vol. Solids %	40±3	38±2	60±3	99±1	65±3
5.	DFT (Micron) / Coat	30-40	30-40	100-125	200-500	100-125
6.	Covering M ² / Coat / Litre	11-15	11-15	5-6	2-3	5.2-6.5
7.	Wt. Kg. / Litre	1.15±0.03	1.15±0.03	1.42±0.03	1.40±0.03	1.40±0.03
8.	Touch Dry at 30°C Max.	30 Min.	30 Min.	3 Hrs.	3 Hrs.	4 Hrs..
9.	Hard Dry at 30°C Max. Full Cure at 30°C for Immersion	8 Hrs. NA	8 Hrs.. NA	16 Hrs. 5 days	16 Hrs. NA	48 Hrs. 5 days
10.	Over-coat Interval at 30°C (Min)	12 Hrs.	Overnight.	Overnight. Max.: 5 days	8 Hrs.. Max.: 48 hrs	24 Hrs. Max.:5 days
11.	Pot Life at 30°C for paints -two components	6-8 Hrs.	NA	4-6 Hrs.	30 Min.	4-6 Hrs.
12.	Temperature. Resistance - Dry service - Immersion	80°C -	- 60°C	80°C -	120°C 50°C	- 125°C

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FINISH PAINTS... CONT'D

Sr. No.	Description	FP-5	FP-6	FP-7	FP-8
1.	Technical Name	High Build Epoxy , self-priming type surface tolerant coating (for complete rust control)	Inorganic zinc silicate coating	Aluminum Paint Heat resistant synthetic medium based suitable up to 250°C dry temp	Silicone Aluminum Paint Heat resistant suitable up to 500°C dry temp.
2.	Pack Type	Two pack	Two pack	Two pack	Single pack
3	Composition	Epoxy resin based suitable pigmented and capable of adhering to manually prepared surface and old coating.	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. Zinc purity shall be Type-II of ASTM D520	Heat resistant synthetic medium based Aluminium paint suitable upto 250°C.	Silicon resin based medium with Aluminum flakes.
4.	Vol. Solids %	78±3	60±3	38±0.03	20±2
5.	DFT (Micron) / Coat	100-125	65-75	15-20	15-20
6.	Covering M ² / Coat / Litre	6.0-7.2	8-9	10-12	8-10
7.	Wt. Kg. / Litre	1.41 ± 0.03	2.3 ± 0.03	0.95 ± 0.03	1.0 ± 0.03
8.	Touch Dry at 30°C Max.	3 Hrs.	30 Min.	3 Hrs.	30 Min.
9.	Hard Dry at 30°C Max. Full Cure 30°C for Immersion	24 Hrs. 5 days	12 Hrs. NA	12 Hrs. NA	24 Hrs. NA
10.	Over-coat Interval Min.	10 hrs.	12 hrs. at 20°C & 50% RH.	24 hrs.	24 hrs.
11.	Pot Life at 30°C	90 Min.	4-6 Hrs.	NA	NA
12.	Temperature. Resistance Min. Dry service	80°C	540°C.	250°C	500°C .

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FINISH PAINTS... CONT'D

Sr. No.	Description	FP-9	FP-10	FP-11	FP-12
1.	Technical Name	Coal Tar Epoxy Polyamine cured	Epoxy Phenolic coating Two-component cured with Polyamine adduct hardner system (primer + intermediate coat + finish paint).	Poly Siloxane Coating - ambient temperature curing / High build inorganic copolymer based Aluminium coating, cold applied suitable for under insulation coating of CS and SS piping for high temperature service	High Build Epoxy phenolic based - Two components solvent free type / Novalac Epoxy Phenolic coating
2.	Pack Type	Single pack	Two pack	Two pack	Single pack
3	Composition	Specially formulated polyamine cured coal tar epoxy suitable for application under insulation	Temperature curing epoxy phenolic coating system suitable for application under insulation of CS/AS/SS piping	Amercoat 738 from PPG Protective & Marine Coatings or Interterm 751 CSA of International (Akzo Nobel). Note: 6	High build epoxy phenolic / Novalac Epoxy phenolic coating cured with Polyamine adduct hardner system
4.	Vol. Solids %	70 ± 3	70 ± 3	60 ± 2	98 -100
5.	DFT (Micron) / Coat	100-125	75-100	75-100	125-150
6.	Covering M ² / Coat / Litre	5-8	4-5	7-9	6.5-8
7.	Wt. Kg. / Litre	1.45 ± 0.03	1.65 ± 0.03	1.3	1.7
8.	Touch Dry at 30°C Min.	4 Hrs.	3 Hrs.	1 Hrs.	2 Hrs.
9.	Hard Dry at 30°C Max.Full Cure 30°C for Immersion	24 Hrs. 168 Hrs.(7days)	24 Hrs. 168 Hrs.(7days)	16 Hrs. -	24 Hrs. 168 Hrs.7days)
10.	Over-coat Interval Min,	6 Hrs. Max.: 5 days	16 Hrs. Max.: 21 days	16 Hrs.. Max.: NA	16 Hrs. Max.: 21 days
11.	Pot Life at 30°C	4 Hrs.	4-6 Hrs.	1 Hr.	1 Hr.

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12.	Temperature. Resistance Min.	-45°C to 125°C under insulation And immersion	-45°C to 150°C under insulation & immersion. (Note: 5)	<ul style="list-style-type: none"> • Up to 400 °C for CS & SS for Intertherm 751 CSA • Up to 480 °C for CS and up to 600 °C for SS for Amercoat 738 (Note 6) 	-45°C to 150°C for immersion service
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Notes:

1. Covering capacity and DFT depends on method of application. Covering capacity specified above is theoretical. Allowing the losses during application, min. specified DFT shall be maintained.
2. All primers and finish coats shall 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 shall be ensured. In case of conflict between this specification and manufacturer's recommendation, the same shall be clarified with Engineer in charge.
4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.
5. FP-10 Two-component Epoxy phenolic coating cured with Polyamine adduct hardner system (primer + intermediate coat + finish paint) suitable upto 225°C (Intertherm 228 from M/s Akzo Nobel Coatings India Pvt Ltd. Bangalore). For all other companies, the temperature resistance shall be a maximum of 150°C.
6. FP-11 Ambient temperature curing epoxy poly siloxane Coating or high build cold applied inorganic co-polymer based aluminium coating. Amercoat 738 from PPG Protective & Marine coatings, Mumbai is suitable up to 480°C for CS surfaces and 600°C for SS surfaces. Intertherm 751 from Akzo Nobel Coatings India Pvt Ltd., Bangalore, Inorganic co- polymer cold applied Aluminium spray coating is suitable upto 400°C of CS & SS surfaces.

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13. PAINTING SYSTEM TABLES & SELECTION CRITERIA

13.1 Painting System Tables:

There are 11 painting system tables in this specification covering most of painting and coating works. However, new table may be added based on project requirement for any specific painting works as necessary. The tables are as under:


Table-01	Painting systems for uninsulated piping, equipment and structures in process units, power plant, DM plant, cooling tower, chimney / stack, package units and any other equipment in process units also including offsite in coastal areas
Table-02	Painting system for insulated equipment and piping (under insulation) in process units and off sites (Carbon steel, LTCS, SS & low alloy steel)
Table-03	Painting system for uninsulated storage tanks in process units and off sites (Carbon steel & low alloy steel)
Table-04	Painting system for internal surface of storage tanks in process units and off sites (Carbon steel & low alloy steel)
Table-05	Painting system for external surface of underground piping and vessels in units and off sites (Carbon steel)
Table-06	Painting system for internal protection of components of coolers / condensers in fresh water service in units and off sites (Carbon steel)
Table-07	Painting system for internal protection of components of coolers / condensers in fresh water service in units and off sites (Stainless steel, duplex stainless steel, non-ferrous materials & galvanized steel)
Table-08	Painting system for effluent treatment plants (ETP)
Table-09	Coating systems for gratings, rolling & stationery ladders, spiral stairways and hand rails in all location
Table-10	Repair of pre-erection / pre-fabrication or shop primer after erection / welding of uninsulated piping and equipment in all environments. (CS, LTCS & low allow steel)
Table-11	Painting system for uninsulated Piping, Equipment, Tanks & Package units in Process Units & Off-Sites (Stainless Steel)

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13.2 Table selection Criteria:

The painting Table shall be selected based on following broad parameters given below. The selection criteria shall also be in the order below. All necessary precaution shall be taken in selecting the applicable table. In case of any difficulty Contractor may seek clarification before starting the works from Engineer in charge whose decision shall be final and binding on the Contractor.

Sr. No.	Criteria	Description	Details
1	Plant Location	<ul style="list-style-type: none"> Non Coastal / Inland Coastal / Marine 	More than 50 KM from Sea shore Coastal / Marine Within 50 KM from Sea shore
2	Environment	<ul style="list-style-type: none"> Industrial Industrial Marine 	Use Industrial , if Marine environment is not mentioned
3	Type of facility	<ul style="list-style-type: none"> Units Offsite 	Process Units, Power Plant, Cooling Towers, DM Plant, pipe Rack in units, Package units, chimney/ stack, any other equipment in units Offsite- pipe racks, Piping on Sleepers
4	Temperature Ranges	(-) 180°C to 600°C	Temperature varies for case to case. Selection of painting systems according to the operating temperatures of the line.
5	Material of Const. (MOC)	Carbon Steel (CS) Low Alloy Steel, Stainless Steel (SS)	Aluminium, Copper , Monel, Incoloy, Nickel No painting is required
6	<ul style="list-style-type: none"> Insulated Non Insulated 	Equipment / Piping Equipment / Piping	See Under insulation table

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7	<ul style="list-style-type: none"> Aboveground Underground 	Equipment / Piping Equipment / Piping	Equipment /piping in pit consider underground
8	Surface	<ul style="list-style-type: none"> External Internal 	Equipment /piping Equipment only

NOTES: (For ALL Tables)

1. The list of items specified in tables is not exhaustive. More items may be included for a particular Contract as necessary. The Contractor shall complete painting including prefabrication primer for all the items in his scope of work as per tender documents and instructions of Engineer in charge.
2. If the pre-erection / prefabrication and 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 and advise re-blasting and priming again. Repair of pre- fabrication / pre-erection primer, as instructed, shall be carried out by Contractor.
3. All coating system including surface preparation, primer and finish coat for piping shall be done at site / field only.
4. Finish coating is not permitted at equipment manufacture shop.




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TABLE -01
PAINTING SYSTEMS FOR UNINSULATED PIPING, EQUIPMENT AND STRUCTURES IN
PROCESS UNITS, POWER PLANT, DM PLANT, COOLING TOWER, CHIMNEY / STACK,
PACKAGE UNITS AND ANY OTHER EQUIPMENT IN PROCESS UNITS ALSO INCLUDING
OFFSITES (Carbon Steel, LTCS & Low Alloy Steel)

Sl. No.	Temp.in °C	Surface Preparation & Pre erection / Shop Primer	Painting System (Post-erection / Field)		Total Final DFT in Micr. (min.)	Remarks
			Primer	Finish Coat		
						<ul style="list-style-type: none"> No over coating to be done on FP-6 as it will lead to mud cracking.
1.2	-14 to 100	SSPC-SP-10 FP-6 = 75 µm FP-3A =150 µm FP-1 =35 µm Total DFT at shop = 260 µm	FP-1 =40 µm will apply after pressure water wash & surface rubbing Cumulative DFT = 300		300	<ul style="list-style-type: none"> FP-8 shall be ambient temperature curing type. Finish coat including primer compatible with finish coat. (I.e. field primer) shall be applied at site only.
1.3	101 to 400	SSPC-SP-10; 1 coat of FP-6 @ 65 - 75 micr. DFT / Coat	None	2 Coat of FP-8 @ 20 micr. DFT / Coat 2x20 =40	105 - 115	
1.4	401 to 540	SSPC-SP-10; 1 coat of FP-6 @ 75 micr. DFT / Coat	None	2 Coat of FP-8 @ 25 micr. DFT / Coat (2x25 =50)	125	

➤ For external surface of MS chimney with or without refractory lining and for internal surface without refractory lining, paint system at Sl. No.1.3 of the above table shall be followed.

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- For external surface of RCC Chimney 2 coats of FP-3A @ 100 Micr. DFT/ coat to obtain total DFT of 200 Micr. shall be applied after proper surface preparation as per Clause 9.3.7
- In case of paint systems as per Sl. Nos. 1.3 and 1.4, the colour bands shall be applied over the Aluminum paint as per the Color coding system requirement for specific service of piping.
- For 1.3 & 1.4 finish coat at field may be applied at shop itself and touch-up will be done at field.

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TABLE -02
PAINTING SYSTEM FOR INSULATED EQUIPMENT AND PIPING (UNDER INSULATION) IN
PROCESS UNITS AND OFFSITES (Carbon Steel, LTCS, SS & Low Alloy Steel)

Sl. No.	Temp.in °C	Surface Preparation & Pre erection / Shop Primer	Painting System (Post-erection / Field)		Total Final	Remarks
			Primer / Intermediate	Finish Coat	DFT in Microns (min.)	
2.1	Equipment & Piping - Carbon steel, LTCS and low Alloy steel					
2.1.1	- 45 to 200	SSPC-SP-10 1 coat of FP-10 @ 125 micr. DFT/coat.	None	1 coat of FP-10 @ 75micr. DFT/coat. (1x125=125)	250	
2.1.2	201 to 540	SSPC-SP-10; 1 coat of Titanium catalyzed inorganic ceramic coploymer @ 150 micr. DFT/coat.	None	1 coat of Titanium catalyzed inorganic ceramic coploymer @ 150micr. DFT/coat.	300	
2.2	Piping -Stainless Steel including Alloy-20 (Note:2)					
2.2.1	-180 to 600	For SS SSPC-SP-6 Commercial Blast/ For SS SSPC-SP-1 With non-chloride solvent 1 coat of Titanium catalyzed inorganic ceramic coploymer @ 150 micr. DFT/coat.	None	1 coat of Titanium catalyzed inorganic ceramic coploymer @ 150micr. DFT/coat. (150x1=150)	300	
2.3	No painting is required for insulated Monel, Incoloy and Nickel lines.					

- **"Cyclic Service"** is characterized by rapid temperature fluctuation.
- The blast cleaning abrasives for SS and Alloy steel surfaces shall be Aluminium oxide grits/shots or garnet.
- Surface shall be thoroughly degreased using an appropriate emulsion cleaner and

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abrasive cleaned (sweep blasting) to create a sufficient anchor profile. Abrasive for blast cleaning of stainless steel surfaces shall be performed with a suitable non-metallic abrasive such as aluminum oxide. When hand or power tool cleaning is required on stainless steel, only stainless steel wire brushes that have not been previously used on carbon steel surface must be used. All coatings and solvents for use on stainless steel shall be free of substances such as chlorides and other halides, sulfur, and shall be free of low melting point metals (zinc, aluminum, tin and lead).

- For 2.1.1 ,2.1.2 & 2.2.1 finish coat at field may be applied at shop itself and touch-up will be done at field.



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TABLE -03
PAINTING SYSTEM FOR UNINSULATED STORAGE TANKS IN PROCESS UNITS AND
OFFSITES (Carbon Steel & Low Alloy Steel)

Sl. No.	Temp.in °C	Surface Preparation (Field)	Painting System (In field after welding & erection)		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
3.1	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.					
3.1.1	-14 to 100	SSPC-SP-10	1 coat of FP-6 @ 65-75 micr. DFT/coat +1 coat of PR-3@ 40 micr. DFT/coat.	2 coats of FP=3A @ 100 micr. DFT/coat + 1 coat of FP-1 @ 70 micr. DFT/coat;	345-355	FP-3A should be suitable for occasional water immersion.
3.1.2	101 to 150	SSPC-SP-10	1 coat of FP-10 @ 80 micr. DFT/coat +1 coat of FP-10 intermediate coat @ 80 micr. DFT/coat.	1 coats of FP-10 @80 micr. DFT/coat + 1 coat of FP-1 @ 40 micr. DFT/coat;	280	-
3.1.3	151 to 500	SSPC-SP-10	1 coat of FP-6 @ 65-75 micr. DFT/coat	2 coats of FP-8 @20 micr. DFT/coat (or) 1coat of FP-11 @ 50 micr.	105	-
3.2	External surfaces of bottom plate (soil side) for all storage tanks.					
3.2.1	-14 to 80	SSPC-SP-10	1 coat of FP-6 @ 75 micr. DFT/coat.	2coat of High Glass Flake Epoxy @ 200 micr. DFT/coat.(2x200=400)	475	

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3.2.2	81 to 150	SSPC-SP-10	1 coat of FP-10 @ 80 micr. DFT/ coat +1 coat of FP-10 intermediate coat @ 80 micr. DFT/ coat. (80+80=160)	1 coats of FP-10 finish coat @80 micr. DFT/coat.	240	-
3.2.3	151 to 550	SSPC-SP-10	1 coat of FP-11 @ 125 micr. DFT/coat	1 coats of FP-11 finish coat @80 micr. DFT/coat.	250	-
3.3	For underside of the bottom plate (in case tank is not lifted during PWHT) (see Note 2c)					
3.3.1	-180 to 650	For CS SSPC-SP-6 Commercial Blast For SS SSPC-SP-1 With non-chloride solvent	1 coat of inter polymeric matrix coating @ 125 microns.	2 coat of inter polymeric matrix coating @ 125 microns.	350-400	Products from JOTUN or HI-TEMP coating or SK FOMULATION recommended.

- All paint coating application including primer for tankage shall be carried out at field after erection and completion of all welding.
- For underside of bottom plate, painting shall be carried out before laying of bottom plate for tanks with Non-Post Weld Heat Treatment (PWHT).
- For tanks with PWHT, painting shall be carried out after PWHT.
- In case tank is not lifted during PWHT then painting shall be applied before laying of bottom plate, SI no. 3.3.1 shall be followed.

Caution: PWHT temperature shall not exceed 650°C.




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TABLE -04

PAINTING SYSTEM FOR INTERNAL SURFACE OF STORAGE TANKS IN PROCESS UNITS AND OFFSITES (Carbon Steel & Low Alloy Steel)

Sl. No.	Temp.in °C	Surface Preparation (Field)	Painting System (In field after welding & erection)		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
4.1	Crude oil, ATF, Turpentine oil, Lubricating oil and Vegetable oil 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 carbon steel internals.					
4.1.1	-14 to 90	SSPC-SP-10	1 coat of FP-10 primer@ 80 micr. DFT/coat.	1 coats of FP-10 intermediate coat @80micr. DFT/coat+ 1coat of FP-10 finish coat@ 80 micr.	240 - 300	-
4.2	Petroleum products & Intermediates Like LDO, HSD, Gas oil, Feeds of FCC -PC, FCC-LCO, VGU-HDT, ISOM, DHDT, Reformate, DCU, NHT & Gasoline, Naphtha, Isomerate and Kerosene. 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.					
4.2.1	-14 to 45	SSPC-SP-10	1 coat of FP-6 @ 75 micr. DFT/coat.	-	75	Note-1
4.2.2	46 to 90	SSPC-SP-10	1 coat of FP-10 primer@ 80 micr. DFT/coat+	1 coats of FP-10 intermediate coat @80micr. DFT/coat+ 1coat of FP-10 finish coat@ 80 micr. DFT/coat;	240-300	-
4.3	Raw / Fresh water, Potable water and Fire water All internal surfaces, accessories and roof structures of cone and dome roof tanks					
4.3.1	-14 to 65	SSPC-SP-10	1 coat of PR-3 @ 100 microns. DFT/coat	2 coats of FP3A @ 100 micr. DFT/coat. (2x100=200)	300	Note-2

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4.4	De-mineralized water (DM) All internal surfaces, accessories and roof structures of cone and dome roof tanks					
4.4.1	-14 to 60	SSPC-SP-10	1 coat of PR-3@ 100micr. DFT/coat.	2 coats of FP-3C @ 200 micr. DFT/coat. (2x100=200)	400 - 450	-
4.4.2	61 to 150	SSPC-SP-10	1 coat of FP-10 primer@ 80 micr. DFT/coat.	1 coats of FP-10 intermediate coat @80micr. DFT/coat+ 1coat of FP-10 finish coat@ 80 micr. DFT/coat; (80+80=160)	240 - 300	-
4.5	Hydrochloric Acid (HCl) 10% All internal surfaces, accessories and roof structures of cone and dome roof tanks					
4.5.1	-14 to 60	SSPC-SP-10	None	Natural Rubber Lining	4.5 mm	-
4.6	Aggressive Solvents like Hexane, Hexene, Benzene, Xylene and Toluene All internal surfaces, accessories and roof structures of cone and dome roof tanks.					
4.6.1	-14 to 65	SSPC-SP-10	1 coat of FP-6 @ 75microns. DFT/coat	-	75	-
4.7	Ethylene Glycol (EG) Tanks Internal shell-full height, bottom plate, underside of roof and all accessories					
4.7.1	ALL	SSPC-SP-10	1 coat of FP-10 primer@ 80micr. DFT/coat.	31 coats of Vinyl chloride Co-polymer Amercoat 23 @75micr. DFT/coat (3x75=225)	225	-
4.8	Inside pontoon and inside of double deck of all tanks floating roofs					
4.8.1	-14 to 80	SSPC-SP-3	1 coat of FP-5@ 100micr. DFT/coat.	1 coats of FP-5 coat @100micr. DFT/coat	200	-
4.9	Wet Slops, Amine Solutions, Sour water, Water draw off All internal surfaces, accessories and roof structures of Cone and Dome roof tanks.					


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4.9.1	-14 to 90	SSPC-SP-10	1 coat of Novolac Phenolic Epoxy Primer@ 125micr. DFT/coat.	1coat of Novolac Phenolic Epoxy finish coat@ 125 micr. DFT/coat; (80+80=160)	250	-
4.10	Vacuum Residue, Fuel oil, Dry Slop, Bitumen and other High Temperature Hydrocarbon Liquids. 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.					
4.10.1	Up to 150	SSPC-SP-10	1 coat of FP-12 Primer@ 125micr. DFT/coat.	1 coats of FP-12 intermediate coat @125micr. DFT/coat+ 1coat of FP-12 finish coat@ 125 micr. DFT/coat; (125+125=250)	375	Note-3
4.11	Alkalis up to 50 % Concentration All internal surfaces accessories and roof structures of cone and dome roof tanks					
4.11.1	Up to 60	SSPC-SP-10	1 coats of Novolac Phenolic Epoxy primer @125micr. DFT/coat.	1coats of Novolac Phenolic Epoxy @100micr. DFT/coat. (1x125=1250)	250	-

Notes:

1. FP-6 shall be suitable and resistant for immersion service for the respective Hydrocarbons.
2. FP-3A shall be suitable for drinking water service and should have competent authority certification.
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 above 150°C are not covered in this spec; such cases shall be covered in the job specifications.

TABLE -05

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PAINTING SYSTEM FOR EXTERNAL SURFACE OF UNDERGROUND PIPING AND VESSELS IN UNITS AND OFFSITES (Carbon Steel)

Sl. No.	Temp.in °C	Surface Preparation & Shop Primer	Coating System (Field)		Total	Remarks
			Surface Preparation & Primer	Finish Coat	Final DFT in Microns (min.)	
5.1	External surface of non-insulated underground piping					
5.1.1	25 to 65	-	SSPC-SP-10; Three layer polyethylene coating, thickness as per JSS for coating.			
5.1.2	66 to 150	-	SSPC-SP-10; 1 coat of FP-12 primer @ 125micr. DFT/coat.	1 coats of FP-12 intermediate coat @125micr. DFT/coat+ 1coat of FP-12 finish coat @ 125 micr. DFT/coat;	375	-
5.1.3	151 to 400	-	SSPC-SP-10; 1 coat of FP-11 primer @ 125micr. DFT/coat.	1 coat of FP-11 finish coat @ 125micr. DFT/coat.	250	-
5.2	External surface of non-insulated underground storage vessels					
5.2.1	-14 to 80	SSPC-SP-10; 1 coat of FP-6 @ 65-75 micr. DFT/coat.	-	3 coat of FP-4 @ 100 micr. DFT/coat.	365-375	-
5.2.2	81 to 150	SSPC-SP-10; 1 coat of FP-6 @ 125 micr. DFT/coat.	-	1 coat of FP-12 Intermediate coat @ 125micr. DFT/coat+ 1coat of FP-12 finish coat @ 125 micr. DFT/coat;	375	-
5.2.3	151 to 400	SSPC-SP-10; 1 coat of FP-11 @ 125 micr. DFT/coat.	-	1 coats of FP-11 finish coat @125micr. DFT/coat	250	-



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TABLE -06
PAINTING SYSTEM FOR INTERNAL PROTECTION OF COMPONENTS OF COOLERS /
CONDENSERS IN FRESH WATER SERVICE IN UNITS AND OFFSITES (Carbon Steel)

Sl. No.	Temp.in °C	Surface Preparation & Shop Primer	Coating System (Field)		Total	Remarks
			Surface Preparation & Primer	Finish Coat	Final DFT in Microns (min.)	
6.1	Fresh water boxes, channels, partition plates, end covers and tube sheets etc.					
6.1.1.	Up to 80	SSPC-SP-10;	1 coat of FP-10 @ 80micr.	2 coat of FP-10@ 80 micr. DFT/coat;	240	-
6.1.2.	80 to 140	SSPC-SP-10;	-	1Coat of glass Fibre Reinforced Novolac epoxy of 1.5mm DFT	1500	-

TABLE -07
PAINTING SYSTEM FOR INTERNAL PROTECTION OF COMPONENTS OF COOLERS /
CONDENSERS IN FRESH WATER SERVICE IN UNITS AND OFFSITES
(Stainless Steel, Duplex Stainless Steel, Non-ferrous materials & Galvanized Steel)

Sl. No.	Temp.in °C	Surface Preparation & Shop Primer	Coating System (Field)		Total Final DFT in Microns (min.)	Remarks
			Surface Preparation & Primer	Finish Coat		
7.1	Up to 80	Sweep Blasting	1 coat of FP-10 @ 80micr. DFT/coat;	1 coat of FP-105@ 80 micr. DFT/coat;	160	-
7.2.	80 to 140	Sweep Blasting	-	1Coat of glass Fibre Reinforced Novolac epoxy of 1.5mm DFT	1500	-


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TABLE -08

PAINTING SYSTEM FOR EFFLUENT TREATMENT PLANTS (ETP)

Sl. No.	Temp.in °C	Surface Preparation	Coating System		Total	Remarks
			Primer	Finish Coat	DFT in Microns	
8.1	External Surface of C.S./ M.S. items screens, walk way, bridges, baffles, dual media filters, Vertical pumps, piping in treated effluent sump, bio sludge pump,					
8.1.1	-14 to 80	SSPC-SP-10	1 coat of FP-6 @ 65-75 micr. DFT/coat	2 coats of FP-3A@100 micr. DFT/coat+ 1coat of FP-1 @ 40 micr. DFT/coat; (2x100+40=240)	305 - 315	
8.2	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					
8.2.1	-14 to 80	SSPC-SP-10	1 coat of FP-6 @ 65-75 micr. DFT/ coat.	3 coats of FP-3A @100 micr. DFT/coat (3x100=300)	365 - 375	See * below
8.3	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.					
8.3.1	-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.
8.4	C.S/ M.S Dual media filters (Internal), Chemical dosing tanks(internal) such as Di Ammonium Phosphate (DAP) and Urea					
8.4.1	Up to 60	SSPC-SP-10	Natural Rubber Lining (As per IS 4682, Part I)		4.5mm	Natural Rubber lining shall be applied as per specific manufacturer and Engineer in charge instructions.

- The paint /coating manufacturers shall provide their Quality control test certificate of coating materials (F-3A) for immersion service of the exposed effluent given in 9.2.


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TABLE -09

**COATING SYSTEMS FOR GRATINGS, ROLLING & STATIONERY LADDERS, SPIRAL STAIRWAYS
AND HAND RAILS IN ALL LOCATION**

Sl. No.	Temp.in °C	Coating System	Total DFT in Microns (min,)
9.1	Up to 60	1 coat of High Build Epoxy @ 75 micr. DFT/Coat and 1 coat pf FP-1 @ 50 micr. DFT/Coat	80 microns of finish coat (excluding the thickness of galvanizing) 125

NOTES:

1. No galvanized specimen shall have thickness less than 125 microns.
2. 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.
3. Approved Cold Galvanizing manufacturers are **ZINGA, LOCKTITE** or **Z.R.C.**


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TABLE -10

**REPAIR OF PRE-ERECTION / PRE-FABRICATION OR SHOP PRIMER AFTER ERECTION /
WELDING OF UNINSULATED PIPING AND EQUIPMENT IN ALL ENVIRONMENTS.
(CS, LTCS & low allow steel)**

Sl. No.	Temp.in °C	Surface Preparation	Coating System	Total DFT in Micr (min.)	Remarks
10.1	-90 to 400	SSPC-SP-3	1coat of FP-6	65-75	See note below and clause 5.9.3
10.2	401 to 550	SSPC-SP-3	1coat of FP-8	20	

- The repair of pre-erection / pre-fabrication or Shop Primer given above shall be done for all items requiring repairs. 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 FP-6 or FP-8 as applicable.
- The primer shall be quickly removed from damaged area by mechanical scraping and emery paper conforming to SSPC-SP-3 to expose the white metal. Blast cleans the surface, if possible. Feather the primed surface over the intact adjacent surface(approximately 50mm) surrounding the damaged area by emery paper.


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TABLE -11

**PAINTING SYSTEMS FOR UN-INSULATED PIPING, EQUIPMENT, TANKS & PACKAGE
UNITS IN PROCESS UNITS AND OFFSITES
(STAINLESS STEEL)**

Sl. No.	Temp.in °C	Surface Preparation	Painting System (Post-erection / Field)		Total Final DFT in Micr. (min.)	Remarks
			Primer	Finish Coat		
11.1	0 to 120	SSPC-SP-6 'Sweep blast' using Aluminium Oxide or Garnet abrasive media SSPC-SP-1 With non-chloride solvent	2 Coats of FP-10 @ 125 micr. DFT / Coat 2x125=250	1 Coat of FP-1 @ 75 micr. DFT / Coat 1x75 =75	325	
11.2	121 to 200	SSPC-SP-6 'Sweep blast' using Aluminium Oxide or Garnet abrasive media SSPC-SP-1 With non-chloride solvent	2 Coats of FP-10 @ 125 micr. DFT / Coat 2x125=250	2 Coats of Silicon Acrylic @ 20 micr. DFT / Coat 2x20 =40	290	

- Surface preparation of stainless steel shall be in accordance with IS 8504-2, Sa 1 light blast cleaning to achieve a 25-40µm profile.
- Surface shall be thoroughly degreased using an appropriate emulsion cleaner and abrasive cleaned (sweep blasting) to create a sufficient anchor profile. Abrasive for blast cleaning of stainless steel surfaces shall be performed with a suitable non-metallic abrasive such as aluminum oxide. When hand or power tool cleaning is required on stainless steel, only stainless steel wire brushes that have not been previously used on carbon steel surface must be used. All coatings and solvents for use on stainless steel shall be free of substances such as chlorides and other halides, sulfur, and shall be free of low melting point metals (zinc, aluminum, tin and lead).
- Only air curing heat resistant silicone aluminium paints shall be applied, post heat curing materials are not acceptable
- The colour bands shall be applied over the Aluminum paint as per the Color coding system requirement for specific service of piping.
- Finish coat at field may be applied at shop itself and touch-up will be done at field.


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14. FINISH COLOUR SCHEDULE

14.1 General

This section covers the general colour requirements for structural steelwork and equipment with operating temperatures below 120 deg.C:

Structural Steel, Tanks, Spheres, Electrical Equipment		
Sl. No:	Service	Shade – Shade Number
N/A	Structural Steelwork	Light Grey – RAL 7035
N/A	Spheres and Storage tanks	White – RAL 9003
N/A	Electrical Switch Boards, Cable Conduit and Transformers and all other electrical equipment	Manufacturers Painting standard (including RAL 7035) conforming to relevant code and practices prevailing in the country of manufacture
Un-insulated Equipment, Tanks and Structures		
Sl. No:	Service	Shade – Shade Number
-	Loading Arms (i) Structural Steel (ii) Arms	Light Grey – RAL 7035 Yellow – RAL 1023
96	Heater Structure	Signal Grey – RAL 7004
97	Heater Casing	Aluminium – RAL 9006
98	Vessels and Columns	Aluminium – RAL 9006
99	Hydrogen Bullets	Antique Pink – RAL 3014
100	LPG Vessels	Oxide Red – RAL 3009
101	SO ₂ Vessel	Yellow – RAL 1023
102	Heat Exchangers	Aluminium – RAL 9006
103	FO Tank and Hot Tanks	Black – RAL 9017
104	All Other Tanks	Aluminium – RAL 9006
105	Caustic/Amine/Acid Tanks	Gold/Yellow – RAL 1004
106	Sour Water	Sky Blue – RAL 5015
107	Outer Surface in Boiler House	Aluminium – RAL 9006
108	Steam Turbine	Aluminium – RAL 9006
109	Compressors and Blowers	Dk Grey BS4800 18 B 25
110	Pumps	Cobalt Blue RAL – 5013
111	Motors (Except Fire Motors)	Bluish Green RAL 5021
112	Hand Railing	Red – RAL 3001
113	Staircase, Ladders and Walkways	Black – RAL 9017
114	Load lifting equipment & mono rails etc.	Brown – RAL 8003

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Safety Colour Schemes		
Sl. No:	Service	Shade – Shade Number
115	General Structure	Black – RAL 9017
116	Switchgear (including inside sub- station)	Light Grey RAL 7035
117	Dangerous Obstruction	Alternate Black (RAL 9017) and Orange (RAL 2008) Diagonal Banding
118	Dangerous or Exposed Parts of Machinery	Orange – RAL 2008

14.2 Pipe Colour Bands

This section covers the requirements for a colour scheme identifying the contents of piping carrying products. The colour coding system is based on international specifications such as ASME, ANSI, BS and Indian Standards including IOCL's existing specification for colour coding.

The system of coding consists of a ground/base colour superimposed with secondary colour bands. The ground colour identifies the basic nature of the service and the secondary colour bands distinguish the particular service product contained.

Ground colour shall be applied to the entire length of un-insulated piping.

The ground colours and secondary banding colours are defined in section 14.4.

The frequency of banding on un-insulated pipe shall be as follows:

- Unit Area – Bands at intervals of 6 metres
- Offsite Area – Bands at intervals of 10 metres

Each pipe segment will have a minimum of 1 identification band irrespective of length.

Colour bands of the correct size shall be applied to the pipe, at:

- Both sides of valves, tees and other fittings
- Where pipes enter and emerge through walls
- Where pipes enter and emerge from walkway overpasses and battery limits
- At uniform intervals along long sections of pipe
- Adjacent to tanks, vessels and pumps.

Insulated piping shall received ground colouring and coloured (secondary) identification bands at a minimum of either side of valves, flanges and the like, at each change in flow direction and at no greater than 6 metre intervals, ground colours should be 2 metres long.

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Secondary colours are to be applied using adhesive plastic tapes to the specified colour.

Bands widths are shown below for different pipe diameters and are to be spaced 25mm apart when two bands (or more) are used:

Outside diameter of pipe or covering (inches)	Width of colour bands (mm)
< 2"	200
2" – 4"	300
6" – 8"	600
>= 10"	800

Bands shall also be displayed conspicuously near walkways, both sides of culverts, tanks, dykes, vessels, suction and discharge of pumps/compressors, unit battery limit, near valves of line, etc.,

14.3 Identification Lettering

Name of service and direction of flow, for all lines shall be positioned at the following locations:

- Offsite lines: Both sides of culverts, any one side of walkways, near tank dykes, at tank inlet/outlet points and suction/discharge pumps/compressors.
- Unit lines: At the battery limit, suction/discharge of pumps/compressors, near vessels, columns, tanks, exchangers etc.,

Identification/legend letter sizes on piping shall depend on the pipe diameter. Either white or black letters are to be selected so as to afford maximum contrast with the identification band colour.

Outside diameter of pipe or covering (inches)	Size of legend letters (mm)
< 2"	19
2" – 4"	32
6" – 8"	64
>= 10"	89

Pipe contents and direction of flow is to be identified using legend letters and arrows, any hazard must be identified clearly by the legend.

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Size of letters (stenciled or pre-formed adhesive) for equipment shall be:

Equipment	Size of legend letters
Column and vessel	150 mm (height)
Pump, compressor and other machinery	50 mm (height)



Lettering shall be black on pipes painted with light shade colours and white on pipes painted with dark shade colours to give good contrast.

14.4 IOCL Paint Colour Code and Banding

The following base / ground and secondary colour designation for identification of various important services shall be followed:

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Sl. No:	Service	Base/Ground Colour	Secondary Band Colours
	Hydrocarbon Lines – (Un-insulated)		
1.	Crude Sour	Dk Grey BS4800 18 B 25	(x1) Orange – RAL 2008
2.	Crude Sweet	Dk Grey BS4800 18 B 25	(x1) Red – RAL 3001
3.	Lube Oils	Dk Grey BS4800 18 B 25	(x1) Green – RAL 6002
4.	Flare Line	Aluminium – RAL 9006	Aluminium – RAL 9006
5.	L.P.G.	Orange – RAL 2008	(x1) Oxide Red – RAL 3009
6.	Propylene	Orange – RAL 2008	(x2) Oxford Blue – RAL 5003
7.	Naptha	Orange – RAL 2008	(x1) Green – RAL 6002
8.	M.S.	Orange – RAL 2008	(x1) Dk Grey BS4800 18 B 25
9.	AV. Gasoline (96 RON)	Orange – RAL 2008	(x1) Green – RAL 6002 + (x1) White – RAL 9003 + (x1) Red – RAL 3001
10.	Gasoline (regular, leaded)	Orange – RAL 2008	(x1) Black – RAL 9017
11.	Gasoline (premium, leaded)	Orange – RAL 2008	(x1) Blue – RAL 5017
12.	Gasoline (white)	Orange – RAL 2008	(x1) White – RAL 9003
13.	Gasoline (aviation 100/130)	Orange – RAL 2008	(x1) Red – RAL 3001
14.	Gasoline (aviation 115/145)	Orange – RAL 2008	(x1) Purple – RAL 4006
15.	N-Pentane	Orange – RAL 2008	(x2) Blue – RAL 5017
16.	Diesel Oil (white)	Oxide Red – RAL 3009	(x1) White – RAL 9003
17.	Diesel Oil (black)	Oxide Red – RAL 3009	(x1) Yellow – RAL 1023
18.	Kerosene	Oxide Red – RAL 3009	(x1) Green – RAL 6002
19.	HY. Kero	Oxide Red – RAL 3009	(x2) Green – RAL 6002
20.	Disulfide Oil (Ex-Merox)	Oxide Red – RAL 3009	(x1) Black – RAL 9017
21.	M.T.O.	Oxide Red – RAL 3009	(x3) Green – RAL 6002
22.	DHPPA	Oxide Red – RAL 3009	(x2) White – RAL 9003
23.	Flushing Oil	Oxide Red – RAL 3009	(x2) Black – RAL 9017
24.	Lab FS	Oxide Red – RAL 3009	(x2) Dk Grey BS4800 18 B 25
25.	Lab RS	Oxide Red – RAL 3009	(x3) Dk Grey BS4800 18 B 25
26.	Lab (Off. Spec.)	Oxide Red – RAL 3009	(x1) Lt Grey RAL 7036
27.	N-Paraffin	Oxide Red – RAL 3009	(x1) Blue – RAL 5017
28.	Heavy Alkylate	Oxide Red – RAL 3009	(x1) Red – RAL 3001
29.	Blow Down, Vapour Line	Aluminium – RAL 9006	(x1) Brown – RAL 8003
30.	Blow Down	Aluminium – RAL 9006	(x2) Brown – RAL 8003

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Sl. No:	Service	Base/Ground Colour	Secondary Band Colours
31.	A.T.F.	Brown – RAL 8003	(x1) White – RAL 9003
32.	Toluene	Brown – RAL 8003	(x1) Yellow – RAL 1023
33.	Benzene	Brown – RAL 8003	(x1) Green – RAL 6002
34.	Lab Product	Brown – RAL 8003	(x1) Blue – RAL 5017
35.	Fuel Oil	Black – RAL 9017	(x1) Yellow – RAL 1023
36.	Fuel Oil (aromatic rich)	Black – RAL 9017	(x2) Yellow – RAL 1023
37.	Asphalt	Black – RAL 9017	(x1) White – RAL 9003
38.	Slop and Waste Oils	Black – RAL 9017	(x1) Orange – RAL 2008
39.	Slop Aromatic	Black – RAL 9017	(x2) Orange – RAL 2008

Chemical Lines (Un-insulated)			
40.	Tri-Sodium Phosphate	Yellow – RAL 1023	(x1) Violet – RAL 4008
41.	Caustic Soda	Yellow – RAL 1023	(x1) Black – RAL 9017
42.	Sodium Chloride	Yellow – RAL 1023	(x1) White – RAL 9003
43.	Ammonia	Yellow – RAL 1023	(x1) Blue – RAL 5017
44.	Corrosion Inhibitor	Yellow – RAL 1023	(x1) Aluminium – RAL 9006
45.	Hexameta Phosphate	Yellow – RAL 1023	(x2) Black – RAL 9017
46.	Acid Lines	Gold/Yellow – RAL 1004	(x1) Red – RAL 3001
47.	Rich Amine	Yellow – RAL 1023	(x2) Blue – RAL 5017
48.	Lean Amine	Yellow – RAL 1023	(x3) Blue – RAL 5017
49.	Solvent	Yellow – RAL 1023	(x1) Green – RAL 6002
50.	LCS	Yellow – RAL 1023	(x1) Grey – RAL 7001

Water Lines (Un-insulated)			
51.	Raw Water	Sky Blue – RAL 5015	(x1) Black – RAL 9017
52.	Industrial Water	Sky Blue – RAL 5015	(x2) Red – RAL 3001
53.	Treated Water	Sky Blue – RAL 5015	(x1) Oxide Red – RAL 3009
54.	Drinking Water	Sky Blue – RAL 5015	(x1) Green – RAL 6002
55.	Cooling Water	Sky Blue – RAL 5015	(x1) Pale Brown – RAL 8025
56.	Service Water	Sky Blue – RAL 5015	(x1) Red – RAL 3001
57.	Tempered Water	Sky Blue – RAL 5015	(x2) Green – RAL 6002
58.	DM Water	Sky Blue – RAL 5015	(x1) Aluminium – RAL 9006
59.	DM Water above 150°F	Sky Blue – RAL 5015	(x2) Black – RAL 9017
60.	Sour Water	Sky Blue – RAL 5015	(x2) Yellow – RAL 1023

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Sl. No:	Service	Base/Ground Colour	Secondary Band Colours
61.	Stripped Water	Sky Blue – RAL 5015	(x2) Blue – RAL 5017
62.	ETP Treated Water	Sky Blue – RAL 5015	(x2) Oxide Red – RAL 3009

Fire Protection System (Above Ground)			
63.	Fire Water, Foam and Extinguishers	Red – RAL 3001	Red – RAL 3001



Air and Other Gas Lines (Un-insulated)			
64.	Service Air	May Green – RAL 6017	(x1) Red – RAL 3001
65.	Instrument Air	May Green – RAL 6017	(x1) Black – RAL 9017
66.	Nitrogen	May Green – RAL 6017	(x1) Orange – RAL 2008
67.	Freon	May Green – RAL 6017	(x1) Yellow – RAL 1023
68.	Chlorine	Yellow – RAL 1023	(x1) Oxide Red – RAL 3009
69.	SO ₂	Yellow – RAL 1023	(x2) White – RAL 9003
70.	H ₂ S	Orange – RAL 2008	(x2) Oxide Red – RAL 3009
71.	Gas (fuel)	Orange – RAL 2008	(x1) Aluminium – RAL 9006
72.	Gas (sour)	Orange – RAL 2008	(x2) Aluminium – RAL 9006
73.	Gas (sweet)	Orange – RAL 2008	(x1) Red – RAL 3001
74.	Hydrogen	Orange – RAL 2008	(x1) May Green – RAL 6017

Steam and Condensate Lines (Un-insulated)			
75.	HP Steam & VHP Steam Line	Aluminium – RAL 9006	(x1) Yellow – RAL 1023
76.	MP Steam	Aluminium – RAL 9006	(x1) Red – RAL 3001
77.	MLP Steam	Aluminium – RAL 9006	(x1) Orange – RAL 2008
78.	LP Steam	Aluminium – RAL 9006	(x1) Green – RAL 6002
79.	Condensate	Sky Blue – RAL 5015	(x1) White – RAL 9003
80.	Condensate above 150°F	Sky Blue – RAL 5015	(x3) Oxide Red – RAL 3009
81.	BFW	Sky Blue – RAL 5015	(x2) Traffic Red – RAL 3020
Note: For all insulated steam lines, the colour coding shall be followed as given for un-insulated lines with the specified length of colour bands			

Insulated Hydrocarbon Lines			
82.	IFO Supply	Black – RAL 9017	(x1) Yellow – RAL 1023
83.	IFO Return	Black – RAL 9017	(x1) Green – RAL 6002
84.	HPS	Black – RAL 9017	(x1) Red – RAL 3001
85.	Bitumen	Black – RAL 9017	(x2) Red – RAL 3001

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Sl. No:	Service	Base/Ground Colour	Secondary Band Colours
86.	CLO	Black – RAL 9017	(x1) Brown – RAL 8003
87.	VB Tar	Black – RAL 9017	(x2) Brown – RAL 8003
88.	VR AM (Bitumen/VBU Feed)	Black – RAL 9017	(x1) Blue – RAL 5017
89.	VR BH	Black – RAL 9017	(x2) Blue – RAL 5017
90.	VAC. Slop	Black – RAL 9017	(x1) White – RAL 9003
91.	Slop	Black – RAL 9017	(x1) Orange – RAL 2008
92.	Crude Sweet	Dk Grey BS4800 18 B 25	(x1) Red – RAL 3001
93.	Crude Sour	Dk Grey BS4800 18 B 25	(x1) Orange – RAL 2008
94.	VGO/HCU Feed	Oxide Red – RAL 3009	(x1) Signal Grey – RAL 7004
95.	OHCU Bottom/FCCU Feed	Oxide Red – RAL 3009	(x2) Signal Grey – RAL 7004

15. STORAGE

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 Inflammable"** shall be clearly displayed outside. Manufacturer's recommendation shall be followed for storage of paint materials.

16. QUALITY CONTROL, INSPECTION & TESTING

- 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
- The contractor must produce Test Certificate from Pre-Qualified Paint Manufacturer for various tests as specified in this document, for each batch and for each category of product. The Engineer in charge shall have the right to test wet samples of paint from each batch at random for verifying quality of paint supplied. Contractor shall arrange to have such tests, when called for by Engineer in charge, performed at his cost any one of the independent laboratories listed in this document.

Samples for the test will be drawn at random in presence of Engineer in charge or his

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representations. Following tests to be carried out if called for by Engineer in charge:

- Specific Gravity
- % solids by weight (% zinc content in case of inorganic or organic zinc primer)
- Drying time (touch dry & full curing)
- Adhesion
- Flexibility
- Hardness
- Storage stability (pot life)

Test methods for above tests shall be as per relevant ASTM or ISO Standard.

- 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:
 - Surface preparation
 - Primer application
 - Each coat of paint

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

- Test for absence oil and grease after degreasing before blasting.
- Tests for surface finish of blasted surface shall be done by visual inspection using SSPC-VIS1. Clear cellophane tape test as per ISO 8502-9 shall be used to confirm absence of dust on blasted surface. Checks shall be done on each component at least once per 200 m2 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 /m². Checks shall be done on each component at least once per 200 m2 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 ISO: 12944-4 (water cleaning). After cleaning surface shall be retested for salt after drying.
- Blast profile measurement
- Test for blasting Media and Blasting air- 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.

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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.

- **Primer Application:** After surface preparation, the primer should be applied to cover the crevices, comers, 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 and 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 '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.
- 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.
- Final inspection of finished coating shall consist of measurement of:
 - Paint dry film thickness (DFT),

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- Adhesion, and,
- Holiday detection check as well as for finish and workmanship.

- 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-PA 2. Measured DFT shall be within + 10% of the dry film thickness, specified in the specifications.
- 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 D6677. For the knife test, if the rating is better than 8, the adhesion is considered acceptable. The adhesion is defective and:-tested areas shall be repaired afterward using the spot repair procedure. Alternatively, the applicator may perform the adhesion test on a steel coupon 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 m² (2000 ft²) of coated surface.
- Holiday testing shall be conducted in accordance with NACE SP0188. 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 SP0188. 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.
- **Final Inspection of coating system:**

A final inspection shall be conducted prior to the acceptance of the work. The Contractor and the Owner / Engineer in charge shall both be present and they shall sign an agreed inspection report. Such reports shall include:

 - General
 - Names of the painting Contractor and the responsible personnel
 - Dates when work was performed
 - Painting Materials

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- Information on painting materials being applied
- Condition of painting materials received
- Environmental Conditions
 - Weather and ambient conditions
 - Painting periods
- Surface Preparation
 - Condition of surface before preparation
 - Tools and methods used to prepare surface
 - Condition of surface after preparation
- Painting 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

17. **GUARANTEE**

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

18. **QUALIFICATION CRITERIA OF PAINTING CONTRACTOR / SUB-CONTRACTOR**



Painting contractor who is awarded the contract for painting by the Owner, must have necessary equipment's, machinery, tools and tackles for surface preparation, paint application and

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inspection. The contractor must have qualified, trained and experienced surface preparator, paint applicator, inspector and supervisors. The Contractor supervisor, inspector, surface preparator and paint applicator must be conversant with the standards referred in this specification.

19. **QUALIFICATION / ACCEPTANCE CRITERIA FOR PAINT COATING SYSTEM**

- Pre-Qualification of Paint Coating Manufacturer and his Products
Paint / coating manufacture meeting the following requirements shall be considered for supply of their products. Contractor is advised to select coating manufacturer. Only after obtaining prequalification from Owner for the manufacturer based on following requirements. Even those manufacturers, whose names are appearing elsewhere in the tender document, under the list of "Owner Recommended or Approved Vendors", will also be required to meet the following prequalification requirements.
 - Manufacturer should have been in continuous business of paint / coating formulation and manufacturer for at least past 5 years.
 - Manufacturer should possess past experience of supplying his products to hydrocarbon processing industry or offshore platforms in the past 5 years.
 - Coating manufacturer should have supplied at least 10000 litre of an individual product to hydrocarbon processing industry or offshore platform.
 - The manufacturer's manufacturing procedure & QA/QC system shall meet ISO 9001 Requirements and preferably should possess ISO 14000 certificate.
 - The Quality control set up should be manned by qualified paint technologists whose bio data should be sent along with quality control organization chart.
- Pre-Qualification Testing:
Manufacturer should have got his products tested at least one time in last 3 years at a reputed independent laboratory for the following test items. Test certificates which are more than 3 years old will not be considered.

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Test	Test Method
Specific gravity	ASTM D1475
Dipping properties	ASTM D823
Film characteristics	-
Solid content by weight	ASTM D2369
Drying Time	ASTM D1640
Flexibility	ASTM D1737 / D522
Hardness	ASTM D3363
Adhesion	ASTM D2197
Abrasion resistance	ASTM D968/ D1044
DFT/coat	As per SSPC guidelines
Storage Stability	ASTM D1849
Resistance to moisture vapour permeability for 2000 hrs	ASTMD2247
Cyclic Test for the duration of 4200 h (25 cycles a 168 hours)	ASTM D5894
% Zn in Dry film for Inorganic Zinc Silicate primer	-
Chemical Resistance test - 10% & 40% NaOH (applicable only for F-6 & F-15) - 10% H ₂ SO ₄ (applicable only for F-6 & F-15) - 10% Nitric Acid test (applicable only for F-6 & F-15) - Benzene / Toluene (applicable only for F-6 & F-15) - Kerosene (applicable only for F-6 & F-15) - Sea water (applicable only for F-6 & F-15) - MIBK test (applicable only for F-6 & F-15)	ASTM D543
Resistance to water using water immersion (applicable only for F6-, F-7, F-8, F-14 & F-15)	ASTM D870
Dry Heat Resistance test (applicable only for F-9, F-6AIB, F-2, F-15, F-16, Polysiloxane, heat;:resistance Al silicone)	ASTM D2485
Thermal shock resistance test (only for F-9, F-6, Polysiloxane)	ASTM D2485 - 91
Cathodic Disbondment Test	ASTM G42 @60 deg C

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- Each coating product to be qualified shall be identified by the following
 - An infrared scan (fingerprint), for Part A and B, each component as per ASTM D2621
 - Specific gravity of Base and curing agent (Ref. ISO 2811)
 - Ash content (ASTM 01650), volatile and non-volatile matters (ISO 3251) of each component
- The identification shall be carried out on the batch, which is used for the Pre-qualification testing. Pre-qualification of the products shall be carried out at an independent laboratory.
- Test shall be carried out at any one of the following laboratories and tests to be witnessed & certified by third party inspection agency (TUV, BY, DNV)
 - IICT, Hyderabad
 - HBTI, Kanpur
 - DMSRDE, Kanpur
 - BIS Laboratories
 - UICT, Matunga, Mumbai
 - UTES, Kolkata
 - PDIL,-Sindri
 - NTH, Kolkata
- Contractor shall furnish to Owner for approval / acceptance of all necessary documents / information including test certificates to prove that the paint manufacturers, from whom he intends to procure paint products, meet the various requirements for fulfilling the pre-qualification criteria as given above. The paint manufacturer shall be qualified and approved for supply after review / assessment of the submission made by the contractor.
- Contractor along with delivery of paint material has to furnish following information from paint manufacturer to Owner for acceptance / approval of products.
 - a) Batch test certificates (Batch Testing)

Contractor has to produce test certificate from paint manufacturer for each batch and for each category of product for the following test items. Test to be witnessed & certified by third party inspection agency. All test results must mention clearly the batch no. and category of product tested. Tests to be conducted for following properties:

 - Infrared scan for Part A and B, each component
 - Specific Gravity
 - % solids by weight (% zinc content in case of inorganic or organic zinc primer)
 - b) Product information sheet Technical data sheet for each category of product.

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20. METHOD OF SAMPLING & DISPATCH FOR LABORATORY TESTING

(Pre-Qualification tests, Batch testing and Inspection testing)

Samples of coating materials should be submitted to the Govt. laboratory in sealed containers with batch no. and test certificate on regular format of manufacturer's testing laboratory. The sampling shall be certified and sealed by a certifying agency.

All test panels should be prepared by Govt. testing agency coloured photographs of test panels should be taken before and after the test and should be enclosed along with test report.

Sample batch no. and manufacturer's test certificate should be enclosed along with the report. Test report must contain details of observation and rusting if any, as per the testing code.

Manufacturers should intimate the company, details of sample submitted for testing, name of Govt. testing agency, date, and contact personnel of the govt. testing agency. At the end of the test the manufacturer should submit the test reports to the company for approval.

Coating systems for panel test shall be decided after discussion with Owner.