Addendum - 4

To

MRPL Tender No. 9680000M1B dated 11.03.2022

DESIGN, SUPPLY, INSTALLATION, TESTING & COMMISSIONING OF LPG AMINE CONTACTOR FOR LPG AMINE ABSORBER SYSTEM IN PFCC UNIT AT MRPL, MANGALURU, KARNATAKA

With reference to the above tender, bidders are requested to note the following:

The items, conditions, specification and stipulations of the Bidding Documents stand modified to the extent indicated in Annexure -1 - Technical Addendum.

The implications of the same, elsewhere in the tender document shall be taken care of appropriately by the bidders. All other terms and conditions, stipulations and specifications of tender shall remain unaltered.

Bidders shall submit copy of this Addendum-4 including its Annexure-1 with the techno-commercial bid, duly signed and stamped, as a token of having read and understood the same.

Annexure-1: Technical Addendum

Sl. No.	Section No. / Clause No.	The Clause/Description stands Modified as below
1	**MATERIAL REQUISITION FOR LPG AMINE CONTACTOR (DA-33211) , Document Number- 9680-02-MR-201, Rev No. 1,** **7.0 SCOPE OF SUPPLY AND WORK –Sr. No. xli. Surface preparation and painting as per Painting Specification attached with requisition.**	• **BIDDER TO REFER ATTACHED SPECIFICATIONS UNDER LPG AMINE CONTACTOR (DA-33211) , Document Number- 9680-02-MR-201, Rev No. 1,** **7.0 SCOPE OF SUPPLY AND WORK –Sr. No. xli. Surface preparation and painting as per Painting Specification attached with requisition.** **"Refer attached Painting Specifications", Document Number 9680-03-TS-003, REV-0**

MANGALORE REFINERY AND PETROCHEMICAL LIMITED

EPCM SERVICES FOR INSTALLATION OF LPG AMINE ABSORBER SYSTEM IN PFCC UNIT AT MRPL, MANGALURU

STANDARD SPECIFICATION FOR PAINTING

0	08.06.2021	ISSUED FOR INFORMATION	AML	GBJ	CRR
Rev.	**Date**	**Description**	**Prpd.**	**Chkd.**	**Appd.**

Triune Energy Services Pvt. Ltd. New Delhi	STANDARD SPECIFICATION FOR PAINTING	**Document Number**	**Rev**
		9680-03-TS-003	**0**
		Sheet 1 of 4	

INDEX

1.0 EXECUTIVE SUMMARY 3
2.0 PROJECT DESCRIPTION 3
3.0 BASIS FOR PAINTING 3
4.0 ATTACHMENT-A SURFACE PREPARATION AND PROTECTIVE COATING EDB-0014 4

1.0 EXECUTIVE SUMMARY

This document specifies the minimum requirements for the painting for MRPL LPG Amine Absorber System.

2.0 PROJECT DESCRIPTION

MRPL has installed Petrochemical Fluidized Catalytic Cracking (PFCC) unit with a capacity of 2.2 MMTPA. The unit was commissioned in 2014. The process technology was licensed by M/s. Technip Stone and Webster. While processing feed with higher Sulphur content in PFCCU, higher H2S is expected in LPG stream. A New LPG Amine Treatment unit shall be installed to remove the hydrogen sulfide present in the LPG and to minimize the spent caustic generation in existing caustic treatment system.

BDEP was prepared by Technip Stone and Webster and MRPL has selected Triune Engineering Services to provide EPCM services.

3.0 BASIS FOR PAINTING

This project is a Brown field project coming in the PFCC unit of the MRPL refinery. To maintain the consistency in the construction with exiting unit, the existing design basis for Surface Preparation and Protective Coating (EDB-0014) will be used.

4.0 ATTACHMENT-A SURFACE PREPARATION AND PROTECTIVE COATING EDB-0014

Attachment-A

MRPL Engineering Design Basis For Surface Preparation and Protective Coating (NEW CONSTRUCTION)

Rev. No	Date	Purpose
0	04/06/16	Issued for Design

Abbreviations:

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

CONTENTS

DESCRIPTION PAGE NO.

1. General..... 4
2. Scope..... 4
3. Reference Codes & Standards..... 6
4. Equipment..... 7
5. Surface Preparation, Shop Primer. Coating Application & Repair and Documentation. 7
6. Paint Materials..... 16
7. Coating Systems..... 21
8. Coating System for Gratings, Rolling & Stationery Ladders, Spiral Stairways and Hand Rails in All location..... 23
9. Coating System for Offsite Area (Inland Plants)..... 24
10. Coating System for Unit Areas as well as DM, CPP, Cooling Tower of Inland Plants and for All Areas (Unit, Offsite, DM, CPP, etc.) of Coastal Plants..... 25
11. Coating System for Effluent Treatment Plant (ETP)..... 27
12. External Coating Systems for Uninsulated Carbon Steel and Low Alloy Steel Storage Tanks (For All Plant Locations, Coastal or Inland) ï All Process Units & Off-Sites. 28
13. Internal Coating Systems for Carbon Steel and Low Alloy Storage Tanks ï All Process Units & Off-Sites..... 30
14. Coating Systems for External Side of Underground Carbon Steel Plant Piping and Underground Vessels..... 32
15. Coating Under Insulation (Coastal or Inland Plants).All Units Areas & Off-Sites. 33
16. Coating System for Carbon Steel Components of Coolers I Condensers (Internal Protection) for Fresh Water Service..... 34
17. Coating System (Internal Protection) for Galvanized or Non Ferrous or Stainless Steel/ Duplex Stainless Steel Components of Coolers/ Condensers for Fresh Water Service..... 35
18. Storage..... 35
19. Colour Code..... 35
20. Identification of Vessels, Piping etc..... 42
21. Painting for Civil Defence Requirements..... 42
22. Quality Control, Inspection and Testing..... 42
23. Guarantee 46
24. Qualification Criteria of Painting Contractor/Sub-Contractor..... 46
25. Qualification/Acceptance Criteria for Paint Coating System..... 46
26. Method of Sampling & Dispatch for Laboratory Testing..... 48

Annexure-I Specification for TSAC 50

1.0 GENERAL

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

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

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

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

2.0 SCOPE

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

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

2.2 Extent of Work

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

Å All uninsulated Carbon Steel & Alloy Steel equipments like vessels, Columns, Storage Tanks, Exchangers if any, parts of boilers etc.

- All uninsulated carbon steel and low alloy ~~plant and related~~ steel piping, fittings and valves (including painting of identification marks), furnace ducts and stacks.

- All insulated parts of vessels, boilers, chimneys, stacks, piping and steam piping and if any other insulated items present.
- All items contained in a package unit as necessary.
- All structural steel work, pipe, structural steel supports, walkways, handrails, ladders, platforms etc.

- Flare lines, external surfaces of MS chimney with or without refractory lining and internal surfaces of MS chimney without refractory lining. (If present)

- Identification of color bands on all piping as required 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)

- Over insulation surface of equipments and pipes wherever required.

- Painting under insulation for carbon steel, alloy steel and stainless steel as specified.

- Painting of pre-erection/fabrication and Shop primer.

- Repair work of damaged pre-erection/ fabrication and shop primer and weld joints in the field/site before and after erection as required.

- All CS Piping, equipments, storage tanks and internal surfaces of RCC tanks in ETP plant.

- Quality control, testing and inspection during all stages of work (surface preparation, application of coating and testing of furnished coating) **along with the Involvement of Paint Manufacturer.**

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

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

2.3 Documents

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

a. Bill of quantities for piping, equipment, machinery and structures etc
b. Piping Line List.

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

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

3.0 REFERENCE CODES & STANDARDS

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

IS-5	Color coding
RALDUTCH	International Standard for color shade (Dutch Standard)
IS-101	Methods of test for ready mixed paints and enamels
IS-2379	Indian Standard for Pipe line identification-color code
IS0-12944	Corrosion Protection of steel Structures by Protective Paint System
ASTM-Vol6.01&6.03	American standard test methods for Paints and Coatings.
ANSI A 13.l	Scheme for identification of piping systems: American National Standards Institution
SSPC	Steel Structures Painting Council

3.2 Surface Preparation Standards

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

3.2.1 ISO 8501-1/SIS-0559 00: ISO standard for Preparation of steel substrates before application of paints and related products. This standard contains photographs of the various standards on four different degrees of rusted steel and as such is preferable for inspection purpose by the Engineer-In-Charge.

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

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

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

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

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

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

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

c. Mixing and thinning.

d. Application of paints and recommended limit on time intervals in between coats.

4.0 EQUIPMENT

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

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

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

5.1 General

5. 1.1 In order to achieve the maximum durability, one or more of following methods of surface preparation shall be followed, depending on condition of surface to be painted and as instructed by Engineer-In-Charge. Adhesion of the paint film to surface depends largely on the degree of cleanliness of the metal surface. Proper surface preparation contributes more to the success of the paint protective system.

a. Abrasive blast cleaning

b. Mechanical or power tool cleaning

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

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

5.1.3 Irrespective of whether external or internal surface to be coated, blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceed 85%. In case of internal coating of storage tanks, dehumidifier shall be used, to control humidity level below 60%. Dehumidifier should depress the dew point of air in the enclosed space, sufficient enough so as to maintain it 3°C below the metal substrate temperature during centre period of blasting and coating application. During the interval time between application of primer coat and subsequent intermediate and top coats or between blast cleaning completion and start of application of primer coat, dehumidifier unit should be in continuous operation to ensure that no condensation occurs on substrate.

Dehumidifier should be able to maintain grain drop (moisture removal) at the rate of 25 grains per pound of air per hour. Dehumidifier should have capacity of at least 2 air changes per hour of the enclosed space. All necessary psychometric data should be collected by contractor for the given site conditions before starting operation of

dehumidifier to ensure that desired values of dew point, moisture content in enclosed scope is achieved.

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

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

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

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

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

5.2 Procedure for Surface Preparation

5.2.1 Air Blast cleaning with abrasives

The surfaces shall be blast cleaned using one of the abrasives like angular chilled cast iron or steel grit, copper slag or Nickel slag, A1203 particles at pressure of 7kg/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 AB 1 and 8250 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 G 16 - 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 AB 1. Compressed air shall be free from moisture and oil. The blasting nozzles should be venture style with tungsten carbide or boron carbide as the materials for liners. Nozzles orifice may vary from 3/16" to: Y...ò 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 SO microns). If possible vacuum collector shall be installed for collecting the abrasives and recycling.

5.2.2 Mechanical or Power Tool Cleaning

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

5.3 Non-Compatible Shop Coat Primer

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

5.4 Shop coated equipments (coated with Primer & finishing coat) should not be repainted unless paint is damaged. Repair shall be carried out as per Table 7 .2 of paint systems depending upon compatibility of paint.

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

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

As mentioned in section 2.4, all coating application at field (field primer, intermediate and top coat) on equipments, structures, piping, etc, shall be carried out only after its

erection and all welding, testing, steam purging (wherever carried out) have been completed.

5.7 Coating Procedure and Application

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

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

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

5.7.1 Surface shall not be coated in rain, wind or in environment where injurious airborne elements exists, when the steel surface temperature is less than 5°F above dew point when the relative humidity is greater than 85% or when the temperature is below 40°F and when the ambient/substrate temp is below the paint manufacturer's recommended temperature of application and curing. De-humidifier equipment shall be used to control RH and Dew point. The paint application shall not be done when the wind speed exceeds 20km per hour.

5.7.2 Blast cleaned surface shall be coated with one complete application of primer as soon as practicable but in no case later than 4 hrs the same day.

5.7.3 To the maximum extent practicable, each coat of material shall be applied as a continuous film uniform thickness free of probes. Any spots or areas missed in application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.

5.7.4 Each coat shall be in proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for recoating when an additional coat can be applied without the development of any detrimental film irregularities, such as lifting or loss of adhesion of the under coat. Manufacturer instruction shall be followed for inter coat interval.

5.7.5 When the successive coat of the same color have been specified, alternate coat shall be tinted, when practical, sufficiently to produce enough contrast to indicate complete coverage of the surface. The tinting material shall be compatible with the material and not detrimental to its service life and shall be recommended by the original paint manufacturer.

5.7.6 Airless spray application shall be in accordance with the following procedure: as per steel structure paint Manual Vol.1 & Vol.2 by SSPC, USA, Air less spray relies on hydraulic pressure rather than air atomization to produce the desired spray. An air compressor or electric motor issued to operate a pump to produce pressures of 1000 to 6000 psi. Paint is delivered to the spray gun at this pressure through a single hose within the gun; a single paint stream is divided into separate streams, which are forced through a small orifice resulting in atomization of paint without the use of air. This results in more rapid coverage with less over spray. Airless spray usually is faster, cleaner, more economical and easier to use than conventional air spray.

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

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

5.7.7 Brush application of paint shall be in accordance with the following:

a. Brushes shall be of a style and quality that will enable proper application of paint.

b. Round or oval brushes are most suitable for rivets, bolts, irregular surface, and rough or pitted steel. Wide flat brushes are suitable for large flat areas, but they shall not have width over five inches.

c. Paint shall be applied into all comers.
d. Any runs or sags shall be brushed out.
e. There shall be a minimum of brush marks left in the applied paint.

f. Surfaces not accessible to brushes shall be painted by spray, daubers, or sheepskin.

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

5.8 Drying of Coated Surfaces

5.8.1 No coat shall be applied until the preceding coat has dried. The material shall be considered dry for re-coating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats.

Drying time of the applied coat should not exceed maximum specified for it as a first coat; if it exceeds the paint material has possibly deteriorated or maxing is faulty.

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

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

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

5.9 Spot Repair of Damaged Primer

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

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

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

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

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

5.10 Paint Application

5.10.1 Shop priming/pre-erection priming with F9 or F 12 shall be done only on blasted Surface (SSPC-SP-10)

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

5.10.3 Assessment of Painting Requirement

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

- Identify the environment from area classification details and chose the appropriate table.
- Identify the design temperature from the technical documents
- Identify the specific field paint system and surface preparation requirement from the above identified table and temperature range.
- Identify the shop priming requirement from Table 7.1 based on compatibility of the above paint system.
- Identify the need of repair of shop primer and execute as per Table 7 .2.

5.11 Documentation and Records

5.11.1 A written quality plan with procedure for qualification trials and for the Actual work including test and inspection plan & procedure for approval before start of work.

5.11.2 Daily progress report with details of weather conditions, particu1ar of Applications, no of coats and type of materials applied, anomalies, progress of Work versus program.

5.11.3 Results of measurement of temperatures relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority.

5.11.4 Particulars of surface preparation and paint application during trials and during the work.

5.11.5 Details of non-compliance, rejects and repairs.

5.11.6 Type of testing equipments and calibration.

5.11.7 Code and batch numbers of paint materials used.

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

After completion of the job, along with the final documentation, contractor shall submit the document for the total quantum of job carried out, quantity of paint used area wise / equipment wise. Test certificates, stage wise inspection reports, manufacturerôs guarantee certificate, stage wise inspection / witness certificate from paint manufacturer.

TABLE-1 (FOR CLAUSE 5.0)
SURFACE PREPARATION STANDARDS

SI. No.	DESCRIPTION	VARIO US INTERNATIONAL ST AND ARDS (EQUIV ALE NT)			REMARKS
		ISO 8501-1/ SIS-OS 59 00	SSPC-SP, USA	NACE, USA	
1.	Manual or hand tool cleaning Removal of loose rust, loose mill scale and loose paint, chipping, scrapping, standing and wire brushing. Surface should have a faint metallic sheen	ST.2	SSPC-SP-2	--	This method is applied when the surface is exposed to normal atmospheric conditions when other methods cannot be adopted and also for spot cleaning during maintenance painting
2.	Mechanical or power tool cleaning Removal of loose rust loose mill scale and loose paint to degree specified by power tool chipping, de-scaling, sanding, wire brushing and grinding, after removal of dust, surface should have a pronounced metallic sheen.	ST.3	SSPC-SP-3	--	
3.	Dry abrasive Blast cleaning There				

	are four common zrades of blast cleaning				
3.1	White metal Blast cleaning to white metal cleanliness. Removal of all visible rust. Mill scale, paint & foreign matter 100% cleanliness with desired surface profile.	SA3	SSPC-SP-5	NACE #l	Where extremely clean surface can be expected for prolong life of paint system.
3·2	Near white metal Blast cleaning to near white metal cleanliness, until at least 95% of each element of surface area is free of all visible residues with desired surface profile	SA 2\12	SSPC-SP-10	NACE #2	The minimum requirement for chemically resistant paint systems such as epoxy, vinyl, polyurethane based and inorganic zinc silicate paints, also for conventional paint systems used under fairly corrosive conditions to obtain desired life of paint system.
3.3	Commercial Blast Blast cleaning until at least two-third of each element of surface area is free of all visible residues with desired surface profile.	SA2	SSPC-SP-6	N0.3	For steel required to be painted with conventional paints for exposure to mildly corrosive atmosphere for longer life of the paint svstems.
3.4	Brush-off Blast Blast cleaning to white metal cleanliness, removal of all visible rust, mill scale, paint & foreign matter. Surface profile is not so imnortant	SA 1	SSPC-SP-7	N0.4	

6.0 PAINT MATERIALS

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

PAINT MATERIALS
TABLE NO.6.1 PRIMERS

SI. No.	DESCRIPTION	P-2	P-4	P-6	P-7
1	Technical name	Chlorinated rubber Zinc Phosphate primer.	Etch primer/ wash primer	Epoxy zinc phosphate primer	ZINGA, LOCKTITE or ZRC cold zalvanizine
2	Type and composition	Single pack, air drying chlorinated rubber based medium plasticised with unsaponifiable plasticizer, pigmented with zinc phosphate.	Two pack polyvinyl butyral resin medium cured with phosphoric acid solution pigmented with zinc tetroxy chromate.	Two component polyamine cured epoxy resin medium, pigmented with zinc phosphate.	One pack Synthetic Resin based zinc galvanizing containing min 92% of electrolytic zinc dust of 99.95% purity.
3	Volume Solids %	40±3	10±1	50±1	37%
4	DFT (Dry Film thickness) per coat in microns	40-45	8-10	40-50	40-50µ
5	Theoritical covering capacity in M2/coat/ litre	8-10	8-10	8-10	4m2/kg
6	Weight per litre in kgs/litre	1.3±0.05	1.2±0.05	1.4±0.05	2.67 kg at 15°C
7	Touch dry at 30°C (minimum)	30 minutes	2 hrs.	After 30 min.	10 minutes
8	Hard dry at 30°C (maximum.)	8 hrs.	24 hrs.	8 hrs	24 hrs.
9	Overcoating interval	Min.: 8 hrs	Min: 4-6 hrs.	Min.:8hrs.	Min.:4 hrs
10	Pot life at 30°C for two component paints	Not Annlicable	Not applicable	6 - 8 hrs.	Unlimited

11	Temperature (Resistance (minimum)	60°C Drv service	NA Drv service	80°C Drv service	50°C Drv service

PAINT MATERIALS
TABLE No. 6.2 FINISH PAINTS

Sl. No.	DESCRIPTION	F-2	F-3	F-6A/B	F-6C	F-7
1	Technical Name	Acrylic Polyurethane Finish paint	Chlorinated rubber based finish paint	Epoxy - High Build coating	Solvent less epoxy coating	High build coal tar epoxy coating
2	Type and composition	Two-pack aliphatic isocynate cured acrylic finish paint	Single pack plasticized chlorinated rubber based medium with chemical and weather resistant pigments.	F-6A Two-pack Aromatic amine cured epoxy resin medium suitably pigmented. F-6B : polyamide cured epoxy resin medium suitably pigmented	Two pack, cured with Amine Adduct; catalyzed epoxy resin suitably pigmented	Two pack polyamide cured epoxy resin blended with coaltar medium, suitably pigmented
3	Volume Solids%	40±3	38±2	60±3	99±1	65±3
4	DFT (Dry Film thickness) per coat in microns	30-40µ	30-40	100-125µ	200-500	100-125µ
5	Theoritical covering capacity in M2/coat/litre	11-15	11-15	5-6	2-3	5.2-6.5
6	Weight per liter in kags/litre	1.15±0.03	l.15±0.03	1.42±0.03	1.40±0.03	1.40±0.03
7	Touch drv at 30°C	30 minutes	30 minutes.	3 hrs.	3 hrs.	4 hrs.
8	Hard dry at 30°C Full cure at 30°C (for immersion/ high	8 hrs	8 hrs	16 Hrs 5 days	16 hrs	48 hrs 5 days
9	Over-coating interval at 30ºC	30 minutes	30 minutes	3 hrs.	3 hrs.	4 hrs.
10	Pot life (approx.) at 30ºC for two component paints	6-8 hrs.	Not applicable	4-6 hrs	30 minutes	4-6 hrs.
11	Temperature Resistance (minimum)	80ºC Dry service min	60ºC Immersion service	80ºC Dry service	120ºC (Dry service), 50ºC (Immersio n service)	125ºC Immersion service

PAINT MATERIALS
TABLE No.6.3 FINISH PAINTS

Sl. No.	DESCRIPTION	F-8	F-9	F-11	F-12
1	Technical name	Self priming type surface tolerant high build epoxy coating (complete rust control coating)	Inorganic zinc silicate coating	Heat resistant synthetic medium based two pack Aluminium paint suitable upto 250ºC dry temp	Heat resistant silicone Aluminium paint suitable upto 500ºC dry temp
2	Type & composition	Two pack epoxy resin based suitable pigmented and capable of adhering to manually prepared surface and old coating	A two pack air drying self curing solvent based inorganic zinc silicate coating with minimum 80% zine content on dry film. The final cure of the dry film shall pass the MEK rub test	Heat resistant synthetic medium based two pack Aluminium paint suitable upto 250ºC	Single pack silicone resin based medium with Aluminium flakes
3	Volume Solids	78+3	60+3	38+0.03	20+2
4	DFT (Dry Film thickness) per coat in microns	100-125	65-75	15-20	15-20
5	Theoretical covering capacity in M^2/coat/litre	6.0-7.2	8-9	10-12	8-10
6	Weight per liter in kgs/litre	1.41+0.03	2.3+0.03	0.95+0.03	1.00+0.03
7	Touch dry at 30ºC (maximum)	3 hrs.	30 minutes	3 hrs.	30 minutes
8	Hard dry at 30ºC (maximum) Full cure 30ºC (for immersion/high temperature service)	24 hrs 5 days	12 NA	12 NA	24 hrs NA

9	Over-coating interval	Min. : 10 hrs	Min. : 12 hrs. at 20ºC & 50% RH	Min. 24 hrs	Min.:24 hrs
10	Pot life at 30ºC for two component paints	90 minutes	4-6 hrs.	Not applicable	Not applicable
11	Temperature Resistance (minimum)	80ºC Dry service	400ºC Dry service	250ºC Dry service	500ºC Dry service

PAINT MATERIALS
TABLE No.6.4 FINISH PAINTS

Sl. No.	DESCRIPTION	F-14	F-15	F-16	F-17
1	Technical name	Polyamine cured coal tar epoxy	Two-component Epoxy phenolic coating cured with Polyamine adduct hardner system (primer + intermediate coat + finish paint)	Ambient temperature curing Poly Siloxane coating/High build cold applied inorganic copolymer based aluminium coating suitable for under insulation coating of CS and SS piping for high temperature service	Two component solvent free type high build epoxy phenolic/novalac epoxy phenolic coating cured with Polyamine adduct hardner system
2	Type & composition	Specially formulated polyamine cured coal tar epoxy suitable for application under insulation	Two pack ambient temperature curing epoxy phenolic coating system suitable for application under insulation of CS/SS piping	Amercoat 738 from PPG Protective & Marine Coatings or Intertherm 751 CSA of International (Akzo Nobel). Note : 6	Two component solvent free type high build epoxy phenolic/novalac epoxy phenolic coating cured with Polyamine adduct hardner system
3	Volume Solids %	70+3	70+3	60+2	98-100
4	DFT (Dry Film thickness) per coat in microns	100-125	75-100	75-100	125-150

5	Theoretical covering capacity in M^2/coat/litre	5-8	4-5	7.0-9.0	6.5-8
6	Weight per liter in kgs/litre (mix paint)	1.45+0.03	1.65+0.03	1.3	1.7
7	Touch dry at 30ºC (maximum)	4 hrs.	3 hrs	1 hr	2 hrs
8	Hard dry at 30ºC (maximum) Full cure 30ºC (for immersion/high temperature service)	24 hrs 168 hrs (7 days)	24 hrs 168 hrs (7 days)	16 hrs	24 hrs 168 hrs (7 days)
9	Over-coating interval	Min. : 6 hrs Max. 5 days	Min. : 36 hrs. Max. 21 days	Min. 16 hrs Max. Not applicable	Min.: 16 hrs Max. : 21 days
10	Pot life at 30ºC for two component paints	4 hrs	4-6 hrs.	1 hr	1 hr
11	Temperature Resistance	-45ºC to 125ºC under insulation and immersion	-45ºC to 150ºC under insulation & immersion (Note : 5)	a) upto 400ºC for C. Steel & S. Steel for Intertherm 751 CSA b) upto 480ºC for C. Steel & upto 600ºC for S. Steel for Amercoat 738	-45ºC to 150ºC for immersion service

NOTES (for tables 6.1 to 6.4):

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

2. All primers and finish coats should be cold cured and air drying unless otherwise specified.

3. All paints shall be applied in accordance with manufacturerôs instructions for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship should be ensured. In case of conflict between this specification and manufacturer's recommendation, the same shall be clarified through EIL SMMS department.

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

5. F-15: Two-component Epoxy phenolic coating cured with Polyamine adduct hardener system (primer + intermediate coat + finish paint) suitable up to 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 l 50°C.

6. F- 16: Ambient temperature curing epoxy poly siloxane Coating or high build cold applied inorganic co-polymer based aluminum 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 Aluminum spray coating is suitable up to 400°C of CS & SS surfaces

7.0 COATING SYSTEMS

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

Classification based on Plant Location:

a. **Plant located in Inland area (more than 50 km from coast);**
   Environment Classification - Industrial

   - For offsite areas: Table 9.0 to be followed

   - For all unit areas including DM.CPP and Cooling Tower: Table 10.0 to be followed

b. **Plant located on sea coast or within 50 km from sea coast;**
   Environment classification- Industrial marine

   - For offsite area, as well as all unit area including DM, CPP, Cooling Tower: Table 10.0 to be followed

c. **For external surface of above ground tanks, table 12.0 to be followed for all locations (Inland or coastal)**

<u>NOTES:</u>

1. Coating systems (Primers, Finish Paints etc.) based on

Area classification/environments/Applications are tabulated in Table 8.0 to Table 17.0

2. Primers & Finish paints covered in Tables 8.0 to 17.0 are listed in Table 7.1.

3. Repair of Pre-Erection/Pre-Fabrication & Shop priming after erection/ welding shall be done as per Table 7.2.

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

PRIMERS	
P-2	Chlorinated rubber zinc Phosphate Primer
P-4	Etch Primer/Wash Primer
P-6	Two component Epoxy Zinc Phosphate Primer cured with polyamine hardner
P-7	Single pack, cold galvanizing compounds containing minimum 92% electrolytie zinc in dry film. Make ZINGA, LOCKTITE (of HENKEL) or ZRC
FINISH COATS / PAINTS	
F-2	Two component Acrylic ï Polyurethane finish paint
F-3	Chlorinated Rubber finish paint
F-6A	High Build Epoxy finish coating cured with polyamine hardener
F-6B	High Build Epoxy finish coating cured with polyamine hardener
F-6C	Solvent less Epoxy Coating cured with poly amine hardener
F-7	High build Coal Tar epoxy coating cured with polyamine hardener
F-8	Self priming surface Tolerant High Build epoxy coating, cured with polyamine hardener
F-9	Two component Inorganic Zinc Silicate coating
F-11	Heat resistant synthetic medium based Aluminium paint
F-12	Two component Heat resistant Silicone Aluminium paint
F-14	Specially formulated coal tar epoxy coating, cured with polyamine hardener
F-15	Two component Epoxy phenolic coating cured with Polyamine adduct hardener system

F-16	Engineered Epoxy poly Siloxane Coating or high build cold applied inorganic co-polymer based aluminium coating
F-17	Two component solvent free type high build epoxy phenolic/novalac epoxy phenolic coating cured with Polyamine adduct hardener system

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

For all un-insulated CS, LTCS & low allow steel items in all Environments

Sl. No.	Design Temp. in ºC	Surface Preparation	Coating System	Total DFT in Microns (min.)	Remarks
7.2.1	-90 to 400	SSPC-Sp-3	1 coat of F-9	65-75	See note below and clause 5.9.3

NOTES:

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

TABLE 8.0 COATING SYSTEMS FOR GRATINGS, ROLLING & STATIONERY LADDERS, SPIRAL STAIRWAYS AND HAND RAILS IN ALL LOCATION

Sl. No.	Design Temp. in ºC	Coating System	Total DFT in Microns (min.)
8.1	Up to 60	Hot Dip Galvanizing to 80-85 microns (600-610 gm/m2) as per IS 4759, 2629, 4736, 2633 + 1 coat of P-6 @ 40 DFT/coat + 1 coat of F-2 @ 40 microns DFT/coat	80 microns of finish coat (excluding the thickness of galvanizing)

NOTES:

1. No galvanized specimen shall have thickness less than 80 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. After repair of damaged galvanized coating by Cold Galvanized, the repaired area shall be top coated with paint system as given in Table 8.0 above (i.e., 1 coat of P-6 @ 40µ DFT/coat + 1 coat of F-2 @40µ OFT/coat).
4. Approved Cold Galvanizing manufacturers are ZINGA, LOCKTITE or Z.R.C.

TABLE 9.0 COATING SYSTEMS FOR OFFSITE AREA (INLAND PLANTS)

For external surfaces of Un-insulated & above ground (atmospheric exposure) Structures, Piping, Vessels, Equipments, Pumps, etc. (Note-1); (For Carbon Steel, LTCS & Low Alloy Steel). See Note Below*

Sl. No.	Design Temp in °C	Surface Preparation & Pre-erection/Shop Primer	Coating System (Post-erection/Field)		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
9.1	-90 to -15	SSPC-Sp-10; 1 coat of F-9 @ 65-75 DFT/coat	None	None	65-75	No over-coating to be done on F-9 as it will lead to mud cracking.
9.2	-14 to 60	SSPC-SP-10; 1 coat of F-9 @ 65-75 DFT/coat	None	1coat of F-2 @ 40 DFT/coat	105.115	
9.3	61 to 80	SSPC-SP-10; 1 coat of F-9 @ 65-75 DFT/coat	None	1 coat of F-2 @ 40 DFT/coat	105-115	
9.4	81 to 250	SSPC-SP-10; 1 coat of F-9 @ 65-75 DFT/coat	None	2 coats of F-11 @ 20 DFT/coat; (2x20=40)	105	
9.5	251-400	SSPC-SP-10; 1 coat of F-9 @ 65-75 DFT/coat	None	2 coats of F-12 @ 20 DFT/coat (2x20=40)	105.115	
9.6	401 to 550	SSPC-SP-10: 1 coat of F-12 @ 20 DFT/coat	None	2 coats of F-12 @ 20 DFT/coat (2x20=40)	60	F-12 shall be ambient temperature curing type.

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

NOTES:

1. The list of items given in the heading of the above table is not exhaustive. There may be more items for a particular contract where these specifications are used. The Contractor is fully responsible for completing painting including prefabrication primer for all the items supplied and fabricated through his scope of work as per tender document.

2. If the Pre-erection/Pre-fabrication & Shop Primer has already been completed, the same shall not be repeated again in the field. In case the damages of primer are severe and spread over large areas, the engineer-in-charge may decide & advise re-blasting and priming again. Repair of preÅfabrication/pre-erection primer, if required, shall be done as per Table 7.2.

3. In case of Paint systems as per SL Nos. 9.5 and 9.6, the color bands shall be applied over the Aluminum paint as per the Color coding requirement for specific service of piping given in Clause 19.0.

4. All coating system including surface preparation, primer, and finish coat for piping hall is done at field only.

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

Sl. No.	Design Temp in ºC	Surface Preparation & Pre-erection/Shop Primer	Coating System (Post-erection/Field)		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
10.1	-90 to -15	SSPC-SP-10; 1 coat of F-9 @ 65-75 DFT/coat	None	None	65-75	a) No over-coating to be done on F-9 as it will lead to mud cracking. b) F-12 shall be ambient temperature curing type c) Finish coat including primer compatible with finish coat (i.e. field primer) shall be applied at site only. Finish coating is not permitted at equipment manufacture shop.
10.2	-14 to 80	SSPC-SP-10; 1 coat of F-9 @ 65-75 DFT/coat	1 coat of P-6 @ 4 DFT/coat	2 coats of F-6A @ 100 DFT/coat + 1 coat of F-2 @ 40 DFT/coat; (2x100+40=240)	345-355	
10.3	81 to 400	SSPC-SP-10; 1 coat of F-9 @ 65-75 DFT/coat	None	2 coats of F-12 @ 20 DFT/coat 2x20=40	105-115	
10.4	401 to 550	SSPC-SP-10; 1 coat of F-12 @ 20 DFT/coat	None	2 coats of F-12 @ 20 DFT/coat (2x20=40)	60	

NOTES:

1. The list of items given in the heading of the above table is not exhaustive. There may be more items for a particular contract where these specifications are used. The Contractor is fully responsible for completing painting including prefabrication primer for all the items supplied and fabricated through his scope of work as per tender document.

2. If the Pre-erection/Pre-fabrication& Shop Primer has already been completed, the same shall not be repeated again in the field. In case the damages of primer are severe and spread over large areas, the engineer-in-charge may decide & advise re-blasting and priming again. Repair of pre- fabrication/pre-erection primer, if required, shall be done as per Table 7 .2.

3. For external surface of MS chimney with or without refractory lining and for internal surface without refractory lining, paint system as per 10.3 above shall be followed.

4. For external surface of RCC Chimney, 2 coats of F-6 @ 100µ DFT/coat to obtain total DFT of 200 µ shall be applied after proper surface preparation as per guidelines in 5.1.6.

5. In case of paint systems as per SL Nos. 10.3 and 10.4, the color bands shall be applied over the Aluminum paint as per the Color coding requirement for specific service of piping given in Clause 19.0.

6. All coating system including surface preparation, primer, and finish coat for piping shall be done at site/field only.

TABLE 11.0 COATING SYSTEMS FOR EFFLUENT TREATMENT PLANT (ETP)

Sl. No.	Design Temp. in °C	Surface Preparation	Coating System		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
11.1	For Internal Surfaces of CS/MS Items: Bio-sludge sump, Filter feed sump, Process sump, Sanitary sump, Transfer sump, Sludge, Slop oil tank, scrapping mechanism in Clarifier					
	-14 to 80	SSPS-SP-10	1 coat of F-9 @ 65-75 DFT/coat	2 coats of F-6A @ 100 DFT/coat of F-2 @ 40 DFT/coat; (2x100+40+240)	305-315	
11.2	For Internal Surfaces of CS/MS Items: Bio-sludge sump, Filter feed sump, Process sump, Sanitary sump, Transfer sump, Sludge, Slop oil tank, scrapping mechanism in Clarifier					
	-14 to 80	SSPS-SP-10	1 coat of F-9 @ 65-75 DFT/coat	3 coats of F-6A @ 100 DFT/coat (3x100+300)	365-375	Note:1
11.3	All R.C.C./concrete surfaces exposed to effluent water / liquid such as tanks, structures, drains etc. in Process sump, TPI separator (Process and Oil), Aeration Tank and Transfer sump etc.					
	-14 to 80	Blast cleaning to SSPC-SP guide lines and Acid etching with 10-15% HCI 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
11.4	C.S/M.S Dual media filters (Internal), Chemical dosing tanks (internal) such as Di-Ammonium Phosphate (DAP) and Urea					
	Up to 60	SSPC-SP-10	Natural Rubber Lining (As per IS 4682, Part 1)		4.5mm	Natural Rubber lining shall be applied as per specific

					manufacturer and Engineer-in-Charge instructions

NOTES :

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

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

All Process Units & Off-sites

Sl. No.	Design Temp. in °C	Surface Preparation (Field)	Coating System		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
12.1	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					
12.1.1	-14 to 80	SSPS-SP-10	1 coat of F-9 @ 65-75 DFT/coat + 1 coat of P-6 @ 40 DFT/coat;	2 coats of F-6A @ 100 DFT/coat + 1 coat of F-2 @ 40 DFT/coat;	345-355	F-6 should be suitable for occasional water immersion
12.1.2	81 to 150	SSPS-SP-10	1 coat of F-15 primer @ 80 DFT/coat + 1 coat of F-15 intermediate coat @ 80 DFT/coat;	1 coat of F-15 finish coat @ 80 DFT/coat + 1 coat of F-2 @ 40 DFT/coat;	280	-
12.1.3	151 to 500	SSPC-SP-10	1 coat of F-9 @ 65-75 DFT/coat	2 coats of F-12 @ 20 DFT/coat Or 1 coat of F-16 @ 50 DFT/coat	105 or 115	-
12.2	External surfaces of bottom plate (soil side) for all storage tanks					
12.2.1	-14 to 80	SSPC-SP-10	1 coat of F-9 @ 65-75 DFT/coat	3 coats of F-7 @ 100 DFT/coat (3x100=300)	365-375	F-7 should be suitable for immersion service of the products given
12.2.2	81 to 150	SSPC-SP-10	1 coat of F-15 primer @ 80 DFT/coat + 1 coat of F-15 intermediate coat @ 80 DFT/coat ; (80+80=160)	1 coat of F-15 finish coat @ 80 DFT/coat	240	-
12.2.3	151 to 550	SSPC-SP-10	1 coat of F-16 @ 125 DFT/coat	1 coat of F-16 @ 125 DFT/coat	250	-
12.3	For underside of the bottom plate (in case tank is not lifted during PWHT) (see Note 2c)					
12.3.1	-180 to 650	For CS SSPC SP-6 Commercial Blast	1 coat of inert polymeric matrix	2 coats of inert polymeric matrix	350-400	Products form JOTUN or HI-TEMP coating or SK

		For SS SSPC SP-1 with non-chloride solvent	coating @ 125	coating @ 125		FORMULATIONS are recommended

NOTES:

1. All paint coating application including primer for tankage shall be carried out at field after erection and completion of all welding.

2. For underside of bottom plate:

a) Painting shall be carried out before laying of bottom plate for tanks with Non-Post Weld Heat Treatment (PWHT).
b) For tanks with PWHT, painting shall be carried out after PWHT.
c) In case tank is not lifted during PWHT then painting shall be applied before laying of bottom plate, clause no. 12.3.l shall be followed.

Caution: PWHT temperature shall not exceed 650°C.

TABLE 13.0 INTERNAL COATING SYSTEMS FOR CARBON STEEL AND LOW ALLOY STORAGE TANKS

All Process Units & Off-sites

Sl. No.	Design Temp. in °C	Surface Preparation (Field)	Coating System		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
13.1	CRUDE OIL, ATF, TURPENTINE OIL, LUBRICATING OIL AND VEGETABLE OIL					
13.1.1	-14 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80 DFT/coat	1 coat of F-15 intermediate coat @ 80 DFT/coat + 1 coat of F-15 finish coat @ 80 DFT/coat;	240-300	-
13.2	PETROLEUM PRODUCTS & INTERMEDIATES like LDO, HSD, GAS OIL, FEEDS of FCC-PC, FCC-LCO, VGO-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 pontoons, support structures and ladders etc.					
13.2.1	-14 to 45	SSPC-SP-10	1 coat of F-9 @ 75 DFT/coat	-	75	Note-2
13.2.2	46 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80 DFT/coat	1 coat of F-15 intermediate coat @ 80 DFT/coat + 1	240-300	-

				coat of F-15 finish coat @ 80 DFT/coat;		
13.3	POTABLE AND FIRE WATER All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
13.3.1	-14 to 45	SSPC-SP-10	1 coat of P-6 @ 100 DFT/coat	2 coats of F-6A @ 100 DFT/Coat; (2x100=200)	300-350	Note-4
13.4	DE-MINERALIZED (DM) WATER All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
13.4.1	-14 to 60	SSPC-SP-10	1 coat of P-6 @ 100 DFT/coat	2 coats of F-6C @ 200 DFT/coat; (2x200=400)	400-450	-
13.4.2	61 to 150	SSPC-SP-10	1 coat of F-15 primer @ 80 DFT/coat	1 coat of F-15 intermediate coat @ 80 DFT/coat + 1 coat of F-15 finish coat @ 80 DFT/coat; (80+80=160)	240-300	-
13.5	HYDROCHLORIC ACID (HCI) 10% All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
13.5.1	-14 to 60	SSPC-SP-10	None	Natural Rubber Lining	4.5 mm	-
13.6	AGGRESSIVE SOLVENTS LIKE HEXANE, HEXENE, BENZENE, XYLENE AND TOLUENE All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
13.6.1	-14 to 65	SSPC-SP-10	1 coat of F-9 @ 75 DFT/coat	-	75	-
13.7	ETHYLENE CLYCOL (EG) TANKS Internal shell-full height, bottom plate, underside of roof and all accessories					
13.7.1	All	SSPC-SP-10	None	3 coats of vinyl chloride co-polymer AMERCOAT 23 @ 75/coat; (3x75+225)	225	-
13.8						
13.8.1	-14 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80 DFT/coat	1 coat of F-15 intermediate coat @ 80 DFT/coat + 1 coat of F-15 finish coat @ 80 DFT/coat; (80+80=160)	240	-

13.10	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 ï including wetted and non wetted surfaces, oil side surfaces of deck plates, oil side surfaces of pontoons, roof structure, structural steel and ladders					
13.10.1	Up to 150ºC	SSPC-SP-10	1 coat of F-17 primer @ 125 DFT/coat	1 coat of F-17 intermediate coat @ 125 DFT/coat + 1 coat of F-17 finish coat @ 125 DFT/coat; (125+125=250)	375	Note:3
13.11	ALKALIS UP TO 505 CONCENTRATION All internal surfaces, accessories and roof structures of Cone and Dome roof tanks					
13.11.1	Up to 60 ºC	SSPC-SP-10	1 coat of F-15 primer @ 80 DFT/coat	2 Coats of F-6 A @ 100 DFT/coat; (2x100=200)	280-100	-

NOTES:

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

2. F-6A should be suitable and resistant for immersion service for the respective Hydrocarbons.

3. This system can be used where maximum operating temperature is below 150°C and design temperature is up to 200°C. Cases of operating temperature > 150°C are not covered in this spec; such cases shall be covered in the job specifications.

4. F-6 A shall be suitable for drinking water service and should have competent authority certification.

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

Sl. No.	Design Temp. in ºC	Surface Preparation (Field)	Coating System		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
14.1	**Underground carbon steel plant piping**					
14.1.1	25 to 35	-	SSPC-SP-10; 1 coat of	1 layer of coaltar tape coating @	4 mm	The primer DFT is not measurable Reconciliation

			synthetic fast drying primer 25 @ DFT/coat	2mm + 1 coat of synthetic fast drying primer 25 @ DFT/coat + 1 layer of coal tar tape coating @ 2mm/layer as per EIL Standard Specification No.6-79-0011		primer shall be done by coverage of maximum to sq.m/litre
14.2.1	66 to 150	-	SSPC-SP-10; 1 coat of F-17 primer @ 125 DFT/coat	1 coat of F-17 intermediate coat @ 125 DFT/coat + 1 coat of F-17 finish coat @ 125 DFT/coat	375	-
14.2.2	151 to 400	-	SSPC-SP-10; 1 coat of F-16 primer @ 125 DFT/coat	1 coat of F-16 finish coat @ 125 DFT/coat	250	-
14.3	**External side of un-insulated underground storage vessels**					
14.3.1	-40 to 80	SSPC-SP-10; 1 coat of F-9 @ 65-75 DFT/coat	-	3 coats of F-7 @ 100 DFT/coat	365-375	-
14.3.2	81-150	SSPC-SP-10; 1 coat of F-17 primer @ 125 DFT/coat	-	1 coat of F-17 intermediate coat @ 125 DFT/coat + 1 coat of F-17 finish coat @ 125 DFT/coat	375	-
14.3.3	151-400	SSPC-SP-10; 1 coat of F-16 primer @ 125 DFT/coat	-	1 coat of F-16 finish coat @ 125 DFT/coat	250	-

TABLE 15.0 COATING UNDER INSULATION (COASTAL OR INLAND PLANTS). ALL UNITS AREAS & OFF-SITES
For insulated Piping, Equipments, Storage vessels, tanks, Columns etc of Carbon Steel, LTCS, Low Alloy Steel & Stainless Steels.

Sl. No.	Design Temp. in °C	Surface Preparation (Field)	Coating System		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
15.1	**Carbon steel, LTCS and low Alloy steel Piping**					
15.1.1	-45 to 120	SSPC-SP-10; 1 coat of F-15 @ 75 DFT/coat	1 coat of F-15 @ 75 DFT/coat	2 coats of F-15 @ 75 DFT/coat; (2x75=150)	225-250	-
15.1.2	121-540	SSPC-SP-10; 1 coat of F-12 @ 20 DFT/coat	None	2 coat of F-12 @ 20 DFT/coat; (2x2=40)	60	-
15.2	**Carbon steel, LTCS and low Alloy steel – Storage vessels, Reactors, Columns & Equipments**					
15.2.1	-45 to 120	SSPC-SP-10; 1 coat of F-15 @ 75 DFT/coat	1 coat of F-15 @ 75 DFT/coat	2 coats of F-15 @ 75 DFT/coat (2x75+150)	225-250	-
15.2.2	121 to 540	Temporary oil based varnish coatings to be provided for transport and storage	Thermally Sprayed Aluminium coating (TSAC) Refer ANNEXURE-I		-	-
15.3	**Stainless Steel (SS) including Alloy-20 piping (Note:2)**					
15.3.1	-180 to Zero	For CS SSPC SP-6 Commercial Blast	1 coat of inert polymeric matrix coating @ 125	2 coats of inert polymeric matrix coating @ 125	350-400	Products from JOTUN or HI-TEMP coatings or SK FORUMATIONS are recommended
15.3.2	0 to 125	SSPC-SP-10 (15-25 surface profile) 1 coat of F-15 @ 80 DFT/coat	1 coat of F-15 intermediate coat @ 80 DFT/coat	1 coat of F-15 finish coat@80 DFT/coat;	240	If the piping & equipments are already erected then surface shall be prepared by cleaning with emery paper and wash/flush with chloride free DM water followed by wiping with

						organic solvent
15.3.3	126 to 400	SSPC-SP-10 1 coat of F-16 @ 125 DFT/coat	None	1 coat of F-16 @ 125 DFT/coat	250	Not recommended for operating temperature
15.3.4	401 to 600	SSPC-SP-10; 1 coat of Amercoat 738@ 125 DFT/coat	None	1 coat of Amercoat 738@125 DFT/coat	250	Between 60-120ºC
15.4	**Coating system for Cyclic Service of Carbon Steel, LTCS, Low Alloy Steel & Stainless Steel**					
15.4.1	-40 to 150	SSPC-SP-10 (15-25 surface profile) 1 coat of F-15 @ 80 DFT/coat	1 coat of F-15 intermediate coat @ 80 DFT/coat	1 coat of F-15 finish coat @ 80 DFT/coat;	240	Apcothern EPN 200 of M/s Asian Paints Ltd OR Equivalent
15.4.2	- 180 to 650	For CS SSPC SP-6 Commercial Blast For SS SSPC-SP-1 with non-chloride solvent	1 coat of inert polymeric matrix coating @ 125	2 coats of inert polymeric matrix coating @ 125	350-400	Products from JOTUN or HI-TEMP coatings or SK FORMULATIONS are recommended
15.5	**No painting is required for insulated Monel, Incoloy and Nickel Lines**					

NOTES:

1. "Cyclic Service" is characterized by rapid temperature fluctuation.
2. The blast cleaning abrasives for SS and Alloy steel surfaces shall be Aluminum oxide grits/shots or garnet.
3. In case of overlapping of temperature ranges as mentioned in 15.4.l and 15.4.2, clause 15.4.1 shall be followed.

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

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

Sl. No.	Design Temp. in ºC	Surface Preparation & Pre-erection/Shop Primer	Coating System (Post-erection / Field)		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		

16.1	Up to 80 °C	SSPC-SP-10	1 coat of F-15 @ 80 microns	2 coats of F-15 @ 80 DFT/coat;	240	-
16.2	80 to 140	SSPC-SP-10	-	1 coat of Glass Fibre Reinforced Novolac epoxy of 1.5 mm DFT	1500	-

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

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

18.0 STORAGE

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

19.0 COLOUR CODE

The following color coding system shall be followed. However alternate color coding may also be followed as per Owner's color coding practice/scheme.

19.1 IDENTIFICATION

The system of color coding consists of a ground color and secondary color bands superimposed over the ground color. The ground color identifies the basic nature of the service and secondary color band over the ground color distinguishes the particular service. The ground color shall be applied over the entire length of the un-insulated pipes. For insulated lines ground color shall be provided as per specified length and interval to identify the basic nature of service and secondary color bands to be painted on these specified length to identify the particular service. Above color code is applicable for both unit and offsite pipelines.

COLOUR CODING

SR. No.	SERVICE	RECOMMENDED COLOUR FOR PAINT SYSTEM	RAL COLOUR COADE			
			BASE COLOUR		BAND COLOUR	
HYDROCARBON LINES (UNINSULATED)						
1	CRUDE SOUR	Dark Admiralty grey with 1 orange band	7012		2011	
2	CRUDE SWEET	Dark Admiralty grey with 1 red band	7012		3001	
3	LUBE OILS	Dark Admiralty grey with 1 green band	7012		6010	
4	FLARE LINES	Heat Resistant Aluminium	9006			
5	LPG	Orange with 1 oxide red band	2011		3009	
6	PROPYLENE	Orange with 2 blue bands	2011		5013	
7	NAPTHA	Orange with 1 green band	2011		6010	
8	M.S.	Orange with 1 dark admiralty grey band	2011		7012	
9	A.V. GASOLINE (96 RON)	Orange with 1 band each of green, white and red bands	2011	6010	9010	3001
10	GASOLINE (regular, leaded)	Orange with 1 black band	2011		9005	
11	GASOLINE (premium, leaded)	Orange with 1 blue band	2011		5013	
12	GASOLINE (white)	Orange with 1 white band	2011		9010	
13	GASOLINE (Aviation 100/130)	Orange with 1 red band	2011		3001	
14	GASOLINE (Aviation 115/145)	Orange with 1 purple band	2011		4006	
15	N-PENTANE	Orange with 2 blue bands	2011		5013	
16	DIESEL OIL (White)	Oxide red with 1 white band	3009		9010	
17	DIESEL OIL (Black)	Oxide red with 1 yellow band	3009		1023	
18	KEROSENE	Oxide red with 1 green band	3009		6010	
19	HY. KEROSENE	Oxide red with 2 green bands	3009		6010	
20	DISUFIDE OIL (EX-MEROX)	Oxide red with 1 black band	3009		9005	

21	M.T.O.	Oxide red with 3 green bands	3009	6010
22	DHPPA	Oxide red with 2 white bands	3009	9010
23	FLUSHING OIL	Oxide red with 2 black bands	3009	9005
24	LAB FS	Oxide red with 2 dark admiralty grey bands	3009	7012
25	LAB RS	Oxide red with 3 dark admiralty grey bands	3009	7012
26	LAB (Off. Spec)	Oxide red with 1 light grey band	3009	7035
27	N-PARAFFIN	Oxide red with 1 blue band	3009	5013
28	HEAVY ALKYLATE	Oxide red with red band	3009	3001
29	BELOW DOWN. VAPOR LINE	Off white / Aluminum with 1-Brown band	9006	8004
30	BLOWDOWN	Off white /Aluminum with 2 brown bands	9006	8004
31	A.T.F.	Leaf brown with 1 white band	8003	9010
32	TOULENE	Leaf brown with 1 yellow band	8003	1023
33	BENZENE	Leaf brown with 1 green band	8003	6010
34	LAB PRODUCT	Leaf brown with 1 blue band	8003	5013
35	FUEL OIL	Black with 1 yellow band	9005	1023
36	FUEL OIL (Aromatic rich)	Black with 2 yellow bands	9005	1023
37	ASPHALT	Black with 1 white band	9005	9010
38	SLOP AND WASTE OILS	Black with 1 orange band	9005	2011
39	SLOP AROMATICS	Black with 2 orange bands	9005	2011
CHEMICAL LINES				
40	TRI-SODIUM PHOSPHATE	Canary yellow with 1 violet band	1012	5000
41	CAUSTIC SODA	Canary yellow with 1 black band	1012	9005
42	SODIUM CHLORIDE	Canary yellow with 1 white band	1012	9010
43	AMMONIA	Canary yellow with 1 blue band	1012	5013
44	CORROSION INHIBITOR	Canary yellow with 1 Aluminum band	1012	9006
45	HEMAMETA PHOSPHATE	Canary yellow with 2 black bands	1012	9005
46	ACID LINES	Golden Yellow with 1 red band	1012	3001
47	RICH AMINE	Canary yellow with 2 blue bands	1012	5013
48	LEAN AMINE	Canary yellow with 3 blue bands	1012	5013
49	SOLVENT	Canary yellow with 1 green band	1012	6010
50	LCS	Canary yellow with 1 smoke grey	1012	7031
WATER LINES				
51	RAW WATER	Sky blue with 1 black band	5015	9005
52	INDUSTRIAL	Sky blue with 2 signal red band	5015	3001

	WATER			
53	TREATED WATER	Sky blue with 1 oxide red band	5015	3009
54	DRINKING WATER	Sky blue with 1 green band	5015	6010
55	COOLING WATER	Sky blue with 1 light brown band	5015	1011
56	SERVICE WATER	Sky blue with 1 signal red brown	5015	3001
57	TEMPERED WATER	Sky blue with 2 green bands	5015	6010
58	DM WATER	Sky blue with 1 aluminum band	5015	9006
59	DM WATER ABOVE 150° F	Sky blue with 2 black bands	5015	9005
60	SOUR WATER	Sky blue with 2 yellow bands	5015	1013
61	STRIPPED WATER	Sky blue with 2 blue bands	5015	5013
62	ETP TREATED WATER	Sky blue with 2 oxide red bands	5015	3009
FIRE PROTECTION SYSTEM (ABOVE GROUND)				
63	FIRE WATER FOAM & EXTINGUISHERS	Post office red	3002	
AIR & OTHER GAS LINES (UNINSULATED)				
64	SERVICE AIR	Sea green with 1 signal red band	6018	3001
65	INSTRUMENT AIR	Sea green with 1 black band	6018	9005
66	NITROGEN	Sea green with 1 orange band	6018	2011
67	FREON	Sea green with 1 yellow band	6018	1023
68	CHLORINE	Canary yellow with 1 oxide band	1012	3009
69	SO_2	Canary yellow with 2 white bands	1012	9010
70	H_2S	Orange with 2 red oxide bands	2011	3009
71	GAS (Fuel)	Orange with 1 aluminum band	2011	9006
72	GAS (Sour)	Orange with 2 aluminum bands	2011	9006
73	GAS (Sweet)	Orange with 2 signal red band	2011	3001
74	HYDROGEN	Orange with 1 light green band	2011	6021
STEAM AND CONDENSATE LINES (UNINSULATED)				
75	HP STEAM	Off white / Aluminum with 1 yellow band	9006	1023
76	MP STEAM	Off white / Aluminum with 1 red band	9006	3001
77	MLP STEAM	Off white / Aluminum with 1 orange band	9006	2011
78	LP STEAM	Off white / Aluminum with 1 light green band	9006	6021
79	CONDENSATE	Sky blue with 1 white band	5015	9010
80	CONDENSATE ABOVE 150° F	Sky blue with 3 oxide red band	5015	3009
81	BFW	Sky blue with 2 red bands	5015	3001
Note : For all insulated steam lines, the colour coding shall be follow as given for un-insulated lines with the specified length of color bands.				

INSULATED HYDROCARBON PIPING				
82	IFO SUPPLY	1 Black ground colour with 1 yellow band in centre	9005	1023
83	IFO RETURN	Black ground colour with 1 green band in centre	9005	6010
84	HPS	Black ground colour with 1 red band in centre	9005	3001
85	BITUMEN	Black ground colour with 2 red bands in centre	9005	3001
86	CLO	Black ground colour with 1 brown band in centre	9005	8004
87	VB TAR	Black ground colour with 1 blue band in centre	9005	8004
88	VR AM (BITUMEN / VBU FEED)	1 Black ground colour with 2 blue bands in centre	9005	5013
89	VR BH	1 Black ground colour with 2 blue bands in centre	9005	5013
90	VAC. SLOP	1 Black ground colour with 1 white band in centre	9005	9010
91	SLOP	1 Black ground colour with 1 orange band in centre	9005	2011
92	CRUDE SWEET	1 Dark admiralty grey ground colour with 1 red band in centre	7012	3001
93	CRUDE OUR	1 Dark admiralty grey ground colour with 1 orange band in centre	7012	2011
94	VGO/ HCU	1 Oxide red ground colour with 2 steel grey bands in centre	3009	7011
95	OHCU BOTOM / FCCU FEED	1 Oxide red ground colour with 2 steel grey bands in centre	3009	7011
UNINSULATED EQUIPMENTS, TANKS AND STRUCTURES				
96	HEATER STRUCTURE	Steel grey	7011	
97	HEATER CASING	Heat resistant aluminium	9006	
98	VESSELS & COLUMNS	Aluminium	9006	
99	HYDROGEN BULLETS	Pink	3014	
100	LPG VESSELS	Oxide red	3009	
101	SO2 VESSEL	Canary yellow	1012	
102	HEAT EXCHANGER	Heat resistant aluminium	9006	
103	FO TANK AND HOT TANKS	Black	9005	
104	ALL OTHER TANKS	Aluminum / Off white	9006	
		Golden yellow	1004	
106	SOUR WATER	Sky Blue	5015	

107	OUTER SURFACE IN BOILER HOUSE	Heat resistant aluminum	9006	
108	COMPRESSORS AND BLOWERS	Dark admiralty grey	7012	
109	PUMPS	Navy blue	5014	
110	MOTORS & SWITCH GEAR	Bluish green	5024	
111	HAND RAILING	Signal red	3001	
112	STAIRCASE, LADDER AND WALKWAYS	Black	9005	
113	LOAD LIFTING EQUIPMENT AND MONORAILS ETC	Leaf brown	8003	
114	GENERAL STRUCTURE	Black	9005	
PIPES AND FITTINGS OF ALLOY STEEL AND SS MATERIAL IN STORE				
115	IBR	Signal red	3001	
116	9Cr-1Mo	Verdigris green	6021	
117	5Cr-0.5Mo	Satin blue	5012	
118	2 ¼ Cr-1Mo	Aircraft yellow	1026	
119	1 ¼ Cr-Mo	Traffic Yellow	1023	
120	SS-304	Dark blue grey	5008	
121	SS-316	Dark violet	4005	
122	SS321	Navy blue	5014	
SAFETY COLOUR SCHEMES				
123	DANGEROUS OBSTRUCTION	Black and alert orange band	9005	2008
124	DANGEROUS OR EXPOSED PARTS OF MACHINERY	Alert orange	2008	

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

All drains & Vents shall be painted in Main line color.
The color code scheme is for identification of piping service group, It consists of a ground color and 1 / 2 color bands.

19.2 Ground Color

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

19.3 Color Bands

Location of color bands:

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

Minimum width:

NB	Width

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

!!! Note: For insulated pipes, NB indicatesOD of the insulation.

Sequence:
Color bands shall be arranged in sequence showing Table above and the sequence follows the direction of flow. The width of the 1Å1 Band to 2nd band is 4:1,

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

19.4 Special Camouflage Painting for Uninsulated Crude and Product Storage Tanks.

Paint specification shall be as per standards.

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

Dark Green	Light green	Medium Brown
5	3	2

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

Patches should be continuous at surface meeting lines *I* points.

Slits / holes shall be painted in dark green shade.

Width of patches shall be 1 to 2 meters.

19.5 Identification Markings on Equipment / Piping

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

Operations Group shall specify location

Sizes shall be:

Columns, Vessels, Heaters:	150mm
Pumps and other M/c	50 mm
Piping	OD I 2 with Maximum l 00 MM
Storage Tanks	(As per Drawings)

19.6 Color Coding for Control Valve

a) Carbon Steel Body - Light grey

Alloy Steel Body - Canary yellow

Stainless Steel Body - Natural

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

Direct action (open on air failure) valves - Green

Reverse acting (close on air failure) valves - Red

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

19.7 Colour Coding for Structural & Others

Sl. No	Item	Color	Indicative
1	Pipe rack structurals	Dark Admiraltry Grey	
2	Chequered Plate (Both faces)	Black	
3	Grating	Black	
4	Ladder Rungs & Railing Vertical Posts	Black	
5	Hand Rail, Middle rail, Toe Plate	Signal Red	
6	Ladder Vertical Posts	Signal Red	
7	Building Structurals, Steel Columns, brackets, beams, bracings, roof trusses, purlings, side girts, louvers, stringers	Dark Admiratry Grey	
8	OverHead Monorail	Signal Red	
9	Gantry Girder & Monorail	Dark Green	
10	Monorail Stopper Plates	Signal Red	
11	Coke Cutting System	Signal Red	
12	EOT/HOT Cranes	Canary Yellow	
13	Transformers & Battery room structurals	Dark Admiraltry Grey	
14	Electrical Motors	Dark Blue	

20.0 IDENTIFICATION OF VESSELS, PIPING ETC

20.1 Equipment number shall be stencilled in black or white on each vessel, column, equipment & machinery (insulated or uninsulated) after painting. Line number in black or white shall be stencilled on all the pipe lines of more than one location as directed by Engineer-In-Charge; Size of letter printed shall be as below:

Column & Vessels	150mm (high)
Pump, compressor & other machinery	50mm (high)
Piping	40-150 mm

20.2 Identification of Storage Tanks

The storage tanks shall be marked as detailed in the drawing.

22.0 QUALITY CONTROL, INSPECTION AND TESTING

22.1 All painting materials including primers and thinners brought to site by contractor for application shall be procured directly from manufactures as per specifications and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates are not acceptable (see section 24.0).

22.2 The contractor must produce Test Certificate from Pre Qualified Paint Manufacturer for various tests as detailed out in section 25.1 of this document, for each batch & 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 the 25.1 of this document.

Samples for the test will be drawn at random in presence Engineer-in-Charge or his 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.

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

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

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

- Test for absence oil & grease after degreasing before blasting as per procedure given in sec 6.7 of Annexure-I of this specification (specification for thermally sprayed Alwninium Coating).
- Tests for surface finish of blasted surface shall be done by visual inspection using SSPC- VIS 1. Clear cellophane tape test as per ISO 8502-3 shall be used to confirm absence of dust on blasted surface. Checks shall be done on each component at least once per 200 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 (2 mg/cm"), 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 IS 12944-4 (water cleaning). After cleaning surface shall be retested for salt after drying.
- Blast profile measurement +This shall be done as described in sec 6.2 of Annexure-I of this specification (Specification for thermally sprayed Aluminum).
- Test for blasting Media and Blasting air- this shall be done as described in sec 6.6 of Annexure-I of this specification (Specification for thermally sprayed Aluminum).

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

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

22.4 Primer Application

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

22.5 The shades of successive coats should be slightly different in color 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-InÅCharge before application of successive coats.

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

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

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

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

22.9 Final inspection of finished coating shall consist of measurement of:

1) Paint dry film thickness (DFT),
2) Adhesion, and,
3) Holiday detection check as well as for finish and workmanship.

1) Coating DFT measurement shall be as per ISO 2808. Type II electromagnetic gauges should be used for ferrous substrates. OFT gauge calibration, number of measurement shall be as per SSPC-DA 2. Measured OFT shall be within + 10% of the dry film thickness, specified in the specifications.

2) Adhesion of the primer to the steel substrate and intercoat adhesion of the subsequent coat(s) after curing for at least a week after application of the topcoat shall be examined by a knife test in accordance with ASTM D 6677. For the knife test, if the rating is better than 8, the adhesion is considered acceptable. The adhesion is destructive and tested areas shall be repaired afterward using the spot repair procedure. Alternatively, the applicator may perform the adhesion test on a steel 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.

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

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

22.11 Final Inspection of coating system

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

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

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

Environmental Conditions
- Weather and ambient conditions
- Coating periods

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

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

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

23.0 GUARANTEE

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

24.0 QUAIFICATION CRITERIA OF PAINTING CONTRACTOR / SUB CONTRACTOR

Painting contractor who is awarded any job for MRPL, Projects under this standard must have necessary equipments, machinery, tools and tackles for surface preparation, paint application and inspection. The contractor mush have qualified, trained and experienced surface preparator, paint applicator, inspector and supervisors. The contractor supervisor, inspector, surface preparator and paint applicator must be conversant with the standards referred in this specification.

25.0 QUALIFICATION/ACCEPTANCE CRITERIA FOR PAINT COATING SYSTEM

25.1 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 MRPL for the manufacturer based on following requirements. Even those manufacturers, whose names are appearing elsewhere in the tender document, under the list of MRPL 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 posses 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 liter of an individual product to hydrocarbon processing industry or offshore platform.

- The manufacturerôs manufacturing procedure & QA/QC system shall meet ISO 9001 requirements and preferably should posses 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.

Test	Test Method
Specific gravity	ASTM D 1475
Dipping properties	ASTM D 823
Film characteristics	-
Solids content by weight	ASTM D 2369
Drying time	ASTM D 1640
Flexibility	ASTM D 1737/ D 522
Hardness	ASTM D 3363
Adhesion	ASTM D 2197
Abrasion resistance	ASTM D 968/ D 1044
DFT/coat	As per SSPC guidelines
Storage Stability	ASTM D 1849
Resistance to moisture vapour permeability for 2000 hrs	ASTM D 2247
Cyclic Test for the duration of 4200 h (25 cycles a 168 hours)	ISO 7253, ASTM G53
% Zn in Dry film for Inorganic Zinc Silicate primer	-
Chemical Resistance test - 10% & 40% NaOH (applicable only for F-6 & F-15) - 10% H_2SO_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 D 543
Resistance to water using water immersion (applicable only for F-6, F-7,F-8, F-14 & F-15)	ASTM D 870
Dry Heat Resistance test (applicable only for F-9, F-6A/B, F-2, F-15, F-16, polysiloxane, heat resistance Al silicone)	
Thermal shock resistance test (only for F-9, F-6, polysiloxane)	ASTM D2485 - 91

Each coating product to be qualified shall be identified by the following

1. An infrared scan (fingerprint), for Part A and B, each component as per ASTM D262
2. Specific gravity of Base and curing agent (Ref. ISO 2811)
3. Ash content (ASTM D1650), volatile and non-volatile matters (ISO 3251) of Each component

The identification shall be carried out on the batch, which is used for the PreÅqualification 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
RITES, Kolkata
PDIL, Sindri
NTH, Kolkata

Contractor shall furnish to MRPL 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 under section 25.l above. The paint manufacturer shall be qualified and approved for supply after review/assessment of the submission made by the contractor.

25.2 Information to be furnished during delivery of coating system:

Contractor along with delivery of paint material has to furnish following information from paint manufacturer to MRPL for acceptance/approval of products.

a) Batch test certificates (Batch Testing)

Along with delivery to site of the paint products from pre-qualified coating manufacturer. 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.

26.0 METHOD OF SAMPLING & DISPATCH FOR LABORATORY TESTING
(Pre-Qualification tests (sec. 25.1), Batch testing (sec. 25.2) and Inspection testing (sec. 22.0))

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

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

Sample batch no. and manufacturerôs 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.

26.3 Manufacturers should intimate the company, details of sample submitted for testing, name of Govt. testing agency, date, 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.

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

ANNEXURE-I

SPECIFICATION FOR THERMALLY SPRAYED ALUMINIUM (TSA) COATING

1.0 SCOPE

The following sections outlines the requirement of supply, application and testing of thermally sprayed aluminum coatings (TSAC) for corrosion protection of insulated carbon steel piping and equipments with design temperature not exceeding 540 ° C.

2.0 ITEMS TO BE THERMALLY SPRAYED

Steel Structures/equipments to be protected by TSAC shall be as per Tables 15.0 of this standard specification. Structures, components thermally sprayed shall not have any uncoated area or shall not be in mechanically connected by flanges etc to any uncoated bare steel work. Such adjacent areas to TSA coated areas, if not coated by TSA shall have suitable paint coating system as per the standard specification.

3.0 TSAC REQUIREMENTS

3.1 Surface Preparation

All the parts to be sprayed shall be degreased according to SSPC-SP 1. The absence of oil and grease after degreasing shall be tested by method given elsewhere in the specification (Refer Sec. 6.7). Thereafter the surface to be abrasive blasted to white metal finish as per NACE l/SSPC-SP *5* for marine and immersion service. Using SSPC VIS I, it is to be visually assessed that the blast cleaned surface meets requirement of SSPC-SP 5. Thereafter clear cellophane tape test as per ISO 8502-3 shall be used to confirm absence of dust on the blasted surface. Finally blasted surface shall be tested for presence of soluble salts as per method ISO 8502-9. Maximum allowable salt content shall be considered 50mg/m2. (5 micrograms/cm2). In case salt content exceeds specified limit. The contaminated surface shall be cleaned by method as per Annex C of IS 12944-4 (Water Cleaning). After cleaning the surface shall be retested for salt content after drying. Testing shall be carried out at least on each component, once per 200 m2 and a min of 3 times per shift during progress of work.

The blasting media shall be either chilled iron or angular steel grit as per SSPC-AB-3 of mesh size G-16 to G-40. Copper, Nickel slag, Garnet or Aluminum Oxide as abrasives will also be suitable having mesh size in the range of Gl6 to G24 (10-30 mesh), conforming to SSPC-AB-1. Mesh size shall be required as appropriate to the anchor tooth depth profile requirement and blasting equipment used. The blasted surface should be having angular profile depth not less than 65 microns with sharp angular shape but shall not exceed 85 microns. The profile depth shall be measured

according to NACE standard RP 0287 (Replica Tape) or ASTM D 4417 method B (Profile depth gauge).

For manual blasting one profile depth measurement shall be taken every 10-20 m2 of blasted surface.

Surface preparation shall be completed in one abrasive blast cleaning operation wherever possible.

If rust bloom (visual appearance of rust) appears on the blast cleaned surface before thermal spraying, the affected area shall be reblasted to achieve specified degree of cleanliness after which only thermal spraying shall commence.

Air blasting pressure at nozzle shall be normally maintained at 100 psi. Air pressure and media size should be reduced and adjusted to preclude damage/distortion to thin gauge materials. Blasting time on work piece should be adjusted to only clean the surface and cut required anchor tooth with minimum loss of metal. Blast angle should be as close to perpendicular as possible but in no case greater than ± 30 ° from perpendicular to work surface. Blasting media must be free of debris, excessive fines, and contaminants such as NaCl and sulfur salts (Ref. SEC 6.0 of this Spec). Blast cleaning shall not be performed when the surfaces to be blasted are wet or less than 5°C above dew point temperature or when the relative humidity in the vicinity of the work is greater than 90%.

3.1. l Blasting Equipment

The TSAC applicator shall use mechanical (centrifugal wheel) or pressure pot blast cleaning equipment and procedures. Suction blasting equipment shall not be used. Sec 6.6.2 shall be used to validate clean and dry air.

3.1.2 Feed Stock

The feed stock shall be in the form of wire. The feed stock shall be 99.5% aluminum of commercial purity grade, its composition shall be in accordance with requirement of BS 1475 or ASTM B833 or ISO 209-1 type Al (wrought aluminum and aluminum alloys, wire). Wire shall be supplied in protective wrapping indicating batch number and other details.

3.1.3 Thickness Requirement

The nominal thickness of finished TSAC shall be 250 microns having minimum value-of225 microns at low thickness areas (valleys) and not more than 275 microns at peak areas.

The finished thickness shall be measured using SSPC-PA 2 type 2 fixed probe gauge (Magnetic Gauge).

3.1.4 Coating Bond Strength Requirement

The TSAC coating shall have a minimum individual tensile-bond strength value of 1000 psi for flame sprayed and 1500 psi for arc sprayed coating with an average of 2000 psi for arc sprayed coatings. Minimum tensile bond strength should be achieved by proper anchor tooth profile of blasted surface, laying down the TSA thickness in multiple passes and carrying out TSA application under controlled environment

3.1.5 Porosity

All thermally sprayed metallic coatings will have porosity. For thermally sprayed aluminum coatings porosity shall not exceed 15% of total surface area for flame sprayed coating and 8% for arc spray coating.

4.0 THERMAL SPRAYAPPLICATIONPROCEDURE

Items in the atmospheric zone to be coated by TSA shall be applied by either Flame spray or Arc spray method only. For coating under insulation, application shall be by arc wire method.

4.1 Equipment Set Up

4.1.1 Thermal spray equipment shall be set up calibrated, operated (1) according to manufacturer instructions/technical manuals and also TSAC applicators refinement thereto and (2) as validated by Procedure Qualification (Sec 7 .0 of this specification).

4.1.2 Spray Parameters

Spray parameters (see 4. I .3 below) and thickness of each crossing pass shall be set and shall be validated with bend test (See 6.5 of this Spec).

4.1.3 Spray Parameters

Spray Parameters	Method of Application	
Arc voltage	Arc wire Spray	Flame Wire Spray
	27 V	-
Air pressure	80 psi	80 psi
Steel surface cleanliness	NACE-1 white metal	NACE-1 white metal / or Near white metal
Steel surface profile	75 microns (minimum)	75 microns (min.)
Arc current	250-280A	-
Coating thickness	225 microns (nominal)	225 microns (Nominal)

Coating adhesion	>1500 psi (Total coating), see 3.1.4	>1000 psi
Coating porosity	Less than 80%	Less than 15%
Spray distance (spray Gun work piece)	6-8ò	5-7ò
Spray Pass width	40 mm	20 mm

The above parameters to be validated with a bend test by the contractor before start of work (for details of bend test see Sec 6.5 of this Spec).

4.2 Post Blasting Substrate Condition and Thermal Spraying Period.

4.2.1 The steel surface temperature shall be at least 5°C above dew point of ambient air temperature.

Steel substrate surface temperature shall be recorded by with a contact pyrometer. Thermal spraying should commence within 15 minutes from the time of completion of blasting

4.2.2 Holding Period

Time between the completion of final anchor tooth blasting and completion of thermal spraying of blasted surface should be no more than four hours. If within this period rust bloom appears Sec 4.4. l of this specification will apply.

4.3 Pre-Heating

For flame spraying, the initial starting area of 1-2 square feet to be preheated to approx.120°C to prevent condensation of moisture in the flame on the substrate. For arc spraying the preheating is not required.

4.4 Thermal Spraying

Spraying should commence only after validation of equipment set up by procedure qualification test and spray parameter validation tests described in Sec 7.0 and 6.5 respectively. Thermal spraying must commence within 15 minutes from the time of completion of blast cleaning

The specified coating thickness shall be applied in several crossing passes. The coating bond strength is greater when the spray passes are kept thin. Laying down an excessively thick spray pass increases the internal stresses in TSAC and decreases the bond strength of total TSAC. The suitable thickness for crossing passes shall be determined by procedure qualification test described in Sec 7.0 of this specification.

For manual spraying, spraying to be done in perpendicular crossing passes to minimize thin spots in coating. Approx. 75-100 microns of TSAC shall be laid down in each pass.

The surface geometry of the item or area to be sprayed should be inspected before application. The spraying pass and sequence shall be planned according to following.

- Maintain Gun as close to perpendicular as possible and within ± 30° from perpendicular to the substrate.
- Maintain nominal standoff distance and spray pass width as given below:

Spray method	Standoff (Inches)	Spray pass width
Arc Wire	6-8	1 ½ (40mm)
Flame Wire	5-7	¾ (20mm)

4.4.1 Rust Bloom (Visual appearance of rust or Discoloration)

If Rust bloom appears on the blasted surface before thermal spraying, the affected area shall be reblasted to achieve the specified level of cleanliness.

If Rust bloom in form of discoloration, or any blistering or a degraded coating appears at any time during application of TSAC, then spraying shall be stopped and acceptable sprayed area shall be marked off. The unsatisfactory areas shall be repaired to the required degree of surface cleanliness and profile.

Blast the edges of the TSAC to provide for 2-3" feathered area overlap of the new work into existing TSAC.

Then apply TSAC to the newly prepared surfaces and overlap the existing TSAC to the extent of feathered edge so that overlap is a consistent thickness.

4.4.2 Masking

Masking all those parts and surfaces which are not required to be thermally sprayed as instructed by purchaser should be inspected by applicator to ensure that they are properly marked and covered by purchaser.

Complex geometries (flanges, valve manifolds, intersections) shall be masked by applicator to minimize overspray i.e. TSAC applied outside spray parameters (primarily gun to substrate distance and spray angle).

4.4.3TSAC Finish

The deposited TSAC shall be uniform without blisters, cracks, loose particles, or exposed steel as examined with 10 X magnification.

5.0 SEALER

Sealant shall be applied after satisfactory application of TSAC and completion of all testing and measurements of the finished TSAC as per Sec 6.0 of this specification.

For shop work Sealer shall be applied immediately after thermal spraying and for field work sealer shall be applied within 8 hours. The sealcoat shall be thin enough to penetrate into the body of TSAC.

The sealant shall be Silicone Alkyd Aluminum paint having OFT not more than *3540* micron. Typically seal coat shall be applied at a spreading rate resulting in theoretical 38 microns OFT. The seal coat shall be applied in accordance with SSPC-PA 1 and the paint manufacturer instruction for sealing.

6.0 TESTING AND MEASUREMENT SCHEDULE

6.1 Surface Finish

That the blasted cleaned surface meets the required criteria (NACE 1/SSPC-SP 5) shall be visually inspected using SSPC-VIS 1. The clear cellophane-tape test as per ISO 8502-3 shall be used to confirm absence of dust or foreign debris on the cleaned surface. Checks shall be done on each component at least once per 200 m2 of blasted surface and minimum of 3 checks per shift.

6.2 **Blast Profile Measurement**: (In-Process testing during actual production before application of TSA coating)

The angular profile depth measurement shall be done by profile tape as per method NACE Standard RP 0287 or ASTM 0 4417 method B (Profile depth gauge micrometer). Spot measurement shall be carried out every 15m2 of blasted surface. At each spot three measurements shall be taken over an area of 10 cm2 and average of measurements to be recorded and reported.
If profile is <65 microns blasting shall continue till greater than 65 microns depth profile is achieved.

6.3 TSAC Thickness (In-Process Testing For finished coating during regular production)

6.3.1 TSAC finished thickness shall be measured using SSPC-PA 2 type 2 fixed probe gauge.

6.3.2 For flat surfaces, measurements shall be taken along a straight measurement line, one measurement line for every 15 m2 of applied TSAC shall be selected along which 5 measurements to be taken at 25 mm internal and average to be reported.

6.3.3 For curved surface or complex geometry, 5 measurements shall be taken at a spot measuring 10 cm2 in area. One spot to be taken for every 15 m2 of applied TSAC area.

6.3.4 The TSAC thickness in surface changes or contour changes, welds and attachments shall be also measured and reported.

6.3.5 If TSAC is less than specified minimum thickness, apply additional TSAC until specified thickness range is achieved.

6.3.6 All locations and values of TSAC thickness measurements shall be recorded in Job Record (JR).

6.4 Tensile Bond Testing (In-Process testing for finished coating during regular production)

- Tensile Bond strength of the TSAC finish coat shall be determined according to ASTM D 4541 using a self-aligning adhesion tester.

- One measurement shall be made every 50 m2Å If tensile bond at any individual spot is less than 1 000 psi for flame sprayed coating and 1500 psi for arc sprayed coating the degraded TSAC shall completely removed and reapplied.

- The tensile bond portable test instrument to be calibrated according to ASTM C 633

6.5 Bend Tests

Bend test shall be carried out at beginning of each work shift. Bend tests shall also be conducted on sample coupons before start of thermal spraying work to qualify the following as mentioned earlier in this specification.

- To qualify spray parameters and thickness of each crossing pass.

6.5.1 Test Procedure

a) Five corrosion control steel coupons each of dimension 50 mm x 150 mm x 1.3 mm thk. to be prepared.

b) Surface shall be prepared by dry abrasive blast cleaning as per this specification.

c) TSAC shall be applied as per specified thickness range. TSAC should be sprayed in crossing passes lying down approx. 75-100 microns in each pass.

d) TSAC applied coupons shall be bent 180 ° around a 13 mm diameter mandrel.

e) Bend test shall be considered passed if on bend radius there is

- No cracking or spalling or lifting by a knife blade from the substrate
- Only minor cracking that cannot be lifted from substrate with a knife blade.

f) Bend test fails if coating cracks with lifting from substrate.

6.6 Tests for blasting media, blasting air

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

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

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

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

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

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

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

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

6.7 Test for presence of oil/grease and contamination

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

a) Visual inspection - Continue degreasing until all visible signs of contamination are removed.
b) Conduct a solvent evaporation test by applying several drops or a small splash of residue-free trichloromethane on the suspect area especially pitting,

crevice corrosion areas or depressed areas. An evaporation ring formation is indicative of oil and grease contamination.
Continue degreasing and inspection till test is passed.

7.0 TSAC APPLICATOR QUALIFICATION

Following tests to be carried out as part of procedure qualification test for the applicator.

- Thickness measurement
- Coating bond strength
- Porosity test
- Bend strength

TSAC applicatorôs surface finishing and application process and equipment set up, calibration and operation shall be qualified by application of TSA on a reference sample which shall be used as a comparator to evaluate the suitability of application process. Only that applicator will be permitted to carry out the work when test specimens coated by the applicator meets the desired requirements as cited below.

The sample shall be made of a steel plate measuring approx. 18"x 18" x *W'* thick. If the actual work is less than *W'* thick then the sample to be made from material of representative thickness.

The surface preparation, TSAC application shall be made with actual field equipments and process/spray parameters and procedures as per the specification. The depth profile of blasted surface, TSAC coating thickness for each cross pass and total thickness range shall be as per specification.

The surface preparation and thermal spraying shall be carried out in representative environmental conditions spraying with makeshift enclosure.

7.1 After application of coating, thickness and tensile bond measurements shall be made in following manner.

- Divide the sample piece into four quadrants.

- Measure thickness along the diagonal line of each quadrant.

- Four each quadrant five in-line thickness measurements at I" interval shall be done using SSPC-J>A 2 type 2 fixed probe gauge. Thus a total of four...five in line" thickness measurements to be done for the whole sample.

- One tensile bond measurement using ASTM D 4541 type III or IV portable self aligning test instrument to be done at centre of each quadrant. Total of 4 measurements for the sample.

- One porosity evaluation test by Metallographic examination shall be conducted to demonstrate the achievement of porosity within the limits specified. Sample shall be prepared for Metallographic examination as per ASTM E- 3.

- The procedure shall be considered qualified if thickness and tensile-bond strength and porosity values meet the specification requirement.

7.2 Bend test: Bend test shall be carried out as detailed at sec. 6.5 of this specification.

Applicators thermal spray equipment set-up, operation and procedure of application including in-process QC checkpoints adopted during procedure qualification as described above should be always subsequently followed during entire duration of work.

8.0 DOCUMENTATION

The following information shall be provided by TSAC applicator before award of work.

- TSAC application process consisting of equipment capabilities and their technical parameters, feed stock material and source of procurement.

- Detailed application procedure and in-process quality control check points for (a) surface preparation (b) thermal spraying (c) seal coats.

- Type and specification of instruments to be deployed for measurement of blast profile depth, TSAC thickness and tensile bond.

- Paint manufacturer data sheet for the selected sealing coat to be applied.

9.0 RECORDS

The TSAC applicator shall maintain job record to record production and QC information. All the results of the tests and quality control checks shall be entered in the record for each component/part thermally sprayed. All the result of tests (thickness, tensile bond, bend tests) and other validation tests (e.g. Procedure qualification test, test for surface cleanliness after abrasive blasting, test for cleanliness of abrasives and air) shall also be recorded and duly signed by owner.

All the information mentioned in Sec 8.0 above should also form part of the Job record.

Any modification affected after procedure qualification in the procedure, QC, spray parameter, equipment spec to the original information (submitted before award of the work) must also form part of Job record.

10.0 WARRANTY

The TSAC applicator shall warrant the quality of material used by providing the purchaser with a certificate of materials used to include

a. Spray feed stock: Alloy type/designation, Lot Number, wire diameter, chemical analysis, name of supplier, manufacturer.

b. Sealant: Name of manufacturer, application data sheet.

11.0 SAFETY

The TSAC applicator shall follow all safety procedures required by the purchaser/owner. Owner shall also give compliance requirement to be followed by applicator. The applicator shall follow all appropriate regulatory requirements.

12.0 CODES AND STANDARDS

This specification shall apply in case of conflict between specification and following applicable standards:

AWS C.2.17	Recommended Practice for Electric are Sprayu
ASTM C 633	Test Method for Adhesive/Cohesive Strength of Flame Sprayed Coatings
ASTM D 4285	Method for indicating Oil or Water in Compressed Air
ASTM D 4417	Test Method for Field Measurement of Surface Profile of Blasted Steel
BS 2569	Specification of Sprayed Metal Coating
NACE Standard RP 0287	Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using a Replica Tape
ASTM D 4541	Test method for Pull-Off Strength of Coating Using Portable Adhesion Testers
ANSI/A WS C2.18	Guide for the Protection of Steel with Thermal Spray Coatings of Aluminum, Zinc and their Alloys and Composites.
NACE No. 12/AWS C2.23M/SSPC-CS 23.00	Specification for the application of thermal spray coatings (Metallizing) of aluminum, zinc and their alloys and composites for the corrosion protection of steel.
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	Ferrus 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 ï White Metal Blast Cleaning

SSPC-VIS 1	Guide and Reference Photographs for Steel Surfaces prepared by Dry Abrasive Blast Cleaning