
PETRONAS TECHNICAL STANDARDS

Protective Coatings and Linings

PTS 15.20.03
November 2017



FOREWORD

PETRONAS Technical Standards (PTS) has been developed based on the accumulated knowledge, experience and best practices of the PETRONAS group supplementing National and International standards where appropriate. The key objective of PTS is to ensure standard technical practice across the PETRONAS group.

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1.0 INTRODUCTION

This PTS provides minimum technical requirement for surface preparations, application procedures, selection of coating and coating systems, enhanced quality control measures, personnel qualifications and updated colour schemes to be used on metallic substrates requiring corrosion protection for new construction and maintenance.

1.1 SCOPE AND DEFINITIONS

1.1.1 The scope of this PTS is for both external and internal coatings meant for onshore and offshore facilities specifically on the metallic substrates for domestic and international projects. It shall also include new construction and maintenance coating systems. This PTS is only applicable to the following listed environments:

- i. Atmospheric (Insulated and Non-Insulated)
- ii. High Temperature
- iii. Immersed
- iv. Splash Zone
- v. Spray Zone
- vi. Sweating

For coating systems which are not mentioned in the above list, the Contractor shall submit the proposed painting system for review and approval by Owner.

Specialised equipment supplied by vendors such as valves, pumps, compressors, etc. should be coated in accordance to specific coating systems as dictated by the environment in Section 3.0 of this PTS.

1.1.2 For existing facilities requiring maintenance, CM's guarantee and warranty as per the clauses mentioned in this PTS shall be obtained for compatibility with existing systems. Other special coatings to be considered should undergo the required testing procedures and obtain approval from Group Technical Authority.

1.1.3 Items excluded from this PTS are listed in APPENDIX L.

1.2 GLOSSARY OF TERM

1.2.1 General Definition of Terms & Abbreviations

Refer to PTS 00.01.03 for PTS Requirements, General Definition Of Terms, Abbreviations & Reading Guide.

1.2.2 Specific Definition of Terms

No	Term	Definition
1	Dry Film Thickness (DFT)	Dry Film Thickness; thickness of the dried or cured coating film.
2	Grit	Particles that are predominantly angular, have fractured faces with sharp edges and are less than half round in shape.
3	Power Tool	A mechanical method of surface preparation widely used in industry and involving the use of power sanders or wire brushes, power chipping hammers, abrasive grinding wheels, needle guns etc.
4	Shot	Particles that are predominantly round, with length of less than twice the maximum particle width and that do not have edges, broken faces or other sharp surface defects.
5	Wet Film Thickness (WFT)	Wet Film Thickness; thickness of wet or uncured coating film.

Table 1.1: Specific Definition of Terms

1.3 SUMMARY OF CHANGES

This PTS 15.20.03 (November 2017) replaces PTS 15.20.03 (February 2016).

2.0 WARRANTY

2.1 GENERAL

- 2.1.1 Contractors, undertaking coating works in accordance with this PTS, shall guarantee the quality of their coating work through specific quality assurance and quality control work processes.
- 2.1.2 The coating system shall be designed to last at least five (5) years for all coatings inclusive of maintenance coatings.

3.0 COATINGS SYSTEMS

3.1 COATING SYSTEMS SELECTION

3.1.1 General

This section addresses the selection of coating system for external and internal application. Selection of coating systems and products which are not listed shall require approval from Owner Technical Authority.

Coating Systems is divided into three categories:

- i. External new construction;
- ii. External maintenance;
- iii. Internal new construction and maintenance.

Prior to the execution of coating works, the items below shall be qualified to the requirements of this PTS:

- i. Coating Systems (APPENDIX A);
- ii. Abrasive materials.

Blasting materials to be used for surface preparation prior to coating shall comply with ISO 8504-2 Abrasive Blast Cleaning. Recycled blasting material shall comply with ISO 8504-2 requirement and use shall be subjected to Owner's approval.

Maintenance and touch-up coating systems shall be compatible with existing construction coating systems. Coating system compatibility shall be tested using patch test methods as described in ASTM D5064.

Dry Film Thickness (DFT) of coating for new construction and maintenance shall have tolerance of $\pm 10\%$.

3.2 COATING SYSTEMS FOR NEW CONSTRUCTION

3.2.1 For new construction, a single Coating Manufacturer (CM) responsibility shall be maintained by using primers, intermediate coats and topcoats from the same CM.

3.2.2 Unless otherwise stated by CM, the surface preparation for new construction shall be blast cleaned to ISO 8501-1, Sa 2.5.

3.2.3 Refer to APPENDIX A for the new coating systems for new construction.

3.3 MAINTENANCE COATING SYSTEMS

3.3.1 Unless otherwise stated by the CM, the surface preparation for maintenance coatings shall be Power Tool Cleaning to SSPC-SP11 or equivalent, as a minimum, unless otherwise required by coating vendor for higher level of surface preparation. Where maintenance coating systems are not listed, coating systems for new construction shall be followed.

3.4 INTERNAL COATING SPECIFICATIONS FOR NEW CONSTRUCTION AND MAINTENANCE

- 3.4.1 This section provides specification for the application of internal coating for new construction and maintenance.
- 3.4.2 Application techniques for the internal coating shall be assessed accordingly to ensure the specified DFT can be achieved e.g. top section of horizontal vessel, upper section of tall vertical wall of tank, etc.
- 3.4.3 For areas which require the application of Glass Fiber Reinforced Matting, the matting shall be installed between the first and the second coat.
- 3.4.4 Internal coating system for potable water tank and jet fuel tank shall comply with this PTS and shall be approved by relevant authorities respectively.
- 3.4.5 Unless otherwise stated by the CM, the surface preparation for internal coating works shall be Sa 2.5, as a minimum. Where existing internal coating systems that is due for maintenance and of unknown specification, the new coating system as listed in this PTS shall be applied as a replacement.
- 3.4.6 Refer APPENDIX A for the specification of internal coating.

3.5 COATING SYSTEM PRODUCT APPROVAL REQUIREMENT

- 3.5.1 New coating products, upgrading of existing product or formulation changes of approved coating products shall be submitted to an approved independent third party laboratory for a full laboratory testing for evaluation by Owner for approval before the product can be considered as an approved product.
- 3.5.2 Details of the testing requirement for the purpose of new and upgraded coating systems, testing qualifications are listed under APPENDIX B.

3.6 PRODUCT QA/QC REPORT

- 3.6.1 CM shall submit QA/QC reports on the coating products that passed the laboratory screening tests. The QA/QC reports shall have the following information:
 - i. Coating Product Name
 - ii. CM Name
 - iii. Batch number
 - iv. Manufacturing date
 - v. Testing date
 - vi. Drying time
 - vii. Hold up property
 - viii. Glossiness

- ix. Specific gravity
- x. Viscosity
- xi. Coatings Fingerprint Certificate

3.6.2 CM shall ensure that the properties of their coating systems selected for actual coating work shall be the same as the ones that passed the laboratory screening tests. Owner may collect ad-hoc coating samples for verification at an approved independent testing agency to verify conformance to the QA/QC report stated herein.

3.6.3 Whenever deemed necessary, Owner reserves the right to carry out a surveillance audit on the CM.

3.7 COATING QUALITY CONTROL BATCH CERTIFICATE

3.7.1 CM shall furnish their Coating Quality Control Batch certificates to ensure that the properties of the products supplied are consistent with the laboratory tested products. The Coatings Fingerprint Certificate shall be produced per batch of coating manufactured and data stored in digital format. This data shall be submitted to the Owner MCI representative from the project team during delivery of coating products. Example of the Coatings Fingerprint Certificate can be found under APPENDIX C.

3.7.2 Owner retains the right to conduct random coating fingerprinting test at any given point during the course of the project as it deems fit. This shall be referenced against fingerprinting results submitted by the CM.

3.7.3 As a minimum, the following information shall be provided:

- i. CM name
- ii. Factory location
- iii. Date of manufacture
- iv. Batch number
- v. Product name
- vi. Generic name
- vii. Key composition/components description:
 - a) Resin
 - b) Pigments
 - c) Curing Agent (generic name)
 - d) Solvent (generic name)
- viii. QC Test Results including Test Standard, Pass Criteria, Actual Results:
 - a) Colour
 - b) Viscosity
 - c) Density/S.G.

- d) Fineness
- e) Drying
- f) Time
- g) Hiding
- h) Power
- i) Gloss

3.7.4 All QC test results shall be provided by CM as and when requested by the Owner.

3.7.5 The unmixed actual coating used for qualification testing shall be marked, retained and properly sealed in a minimum 2" diameter by 2" height stainless steel container for traceability and to avoid product contamination. Owner may conduct fingerprinting test as deemed necessary.

4.0 PRE-CLEANING

4.1 SURFACE PROFILE

- 4.1.1 Roughness or anchor pattern measurement shall be carried out by the Contractor using instruments and procedures approved by the Owner. Where anchor patterns are not specified in the CM technical data sheet, Table 4.1 below shall be used as a guide for determining the anchor pattern.

Dry film thickness	Anchor pattern
125-200 microns (5-8 mills)	25-50 microns (1 -2 mills)
200-500 microns (9-20 mills)	50-76 microns (2-3 mills)
> 500 microns (>20 mills)	75-125 microns (3-5 mills)
125-200 microns (5-8 mills)	25-50 microns (1 -2 mills)

Table 4.1: Relationship between Coating Thickness and Anchor Pattern

- 4.1.2 Abrasives used in blast cleaning steels shall generally be in accordance with ISO 8504-2 and Table 4.2. In the event of other type of abrasive media not described in ISO 8504-2 and Table 4.2 is to be used, prior written approval from Owner shall be obtained.

Type of abrasive	Generic Name	Characteristics	Standard
Metallic	Iron grit	>1.7% carbon	ISO 11124-2
	Steel grit	0.8% to 1.2% carbon	ISO 11124-3
Non-metallic Natural Mineral	Olivine	Magnesium/iron silicate	ISO 11126-8
	Staurolite	Iron/aluminium silicate	ISO 11126-9
	Specular hematite	Crystalline Fe ₂ O ₃	
	Garnet	Calcium iron silicate	ISO 11126-10
	Almandine Garnet	Iron/aluminium silicate	
Non-metallic Synthetic Mineral or Industrial by-product	Coal/copper furnace slag	Aluminium silicate	ISO 11126-4
	Aluminium oxide	Crystalline corundum	ISO 11126-7
	Iron furnace slag	Calcium silicate	ISO 11126-6
	Platinum Slag	Magnesium/iron silicate	ISO 11126-8 / SSPC AB-1 Sect. 2

Table 4.2: Abrasive Specification

- 4.1.3 Aluminium oxide or other abrasives free from any chloride or iron/steel contamination shall be used for blasting stainless steel.

4.2 GRADES OF SURFACE FINISH

4.2.1 Acceptable surface finish grades are summarized in Table 4.3.

Abrasive blast cleaning	SSPC	ISO 8501-1	NACE
White metal blast cleaning	SP5	Sa 3	No. 1
Near white metal cleaning	SP10	Sa 2.5	No. 2
Commercial blast cleaning	SP6	Sa 2	No. 3
Brush-off (Sweep) blast cleaning	SP7	Sa 1	No. 4
Brush-off blast cleaning (Non-ferrous metals)	SP16	n/a	n/a
Power-tool cleaning (to bare metal)	SP11	n/a	n/a
Commercial grade power tool	SP15	n/a	n/a
Power-tool cleaning	SP3	St 2 or 3	n/a
Hand-tool cleaning	SP2	St 2	n/a
Solvent cleaning	SP1	n/a	n/a
Pickling to white metal	SP8	n/a	n/a
High and ultrahigh pressure water jetting	SP12	n/a	No. 5
Water jet cleaning	SP12	n/a	No. 5
Clean to bare substrate water jetting	SP12- WJ-1	n/a	No.5 WJ-1
Very thorough water jetting	SP12- WJ-2	n/a	No.5 WJ-2
Thorough water jetting	SP12- WJ-3	n/a	No.5 WJ-3
Light water jetting	SP12- WJ-4	n/a	No.5 WJ-4
Wet abrasive blasting	TR2	n/a	6G198

Table 4.3: Surface Finish Grades

4.3 SURFACE PREPARATION METHOD FOR STAINLESS STEEL, GALVANIZED STEEL, NICKEL ALLOY AND NON-FERROUS ALLOY

4.3.1 Acceptable surface preparation methods can be varied for this specification subject to the size and the accessibility to the item being coated.

4.3.2 With the exception of galvanized steel, vessels, cabinets, large bore pipes and valves that are constructed of stainless steel and nickel alloy shall be "Brush-off blast cleaned" to standard SSPC SP 16.

4.3.3 Small bore piping, valves and instruments may be prepared by hand tool cleaning or by "sanding" to achieve an abraded surface profile to enable adequate coating adhesion.

4.3.4 Abrasive "Brush-off" Blasting Method

- i. The surface to be blasted shall be washed down with Owner approved biodegradable alkali based detergent or degreaser applied as per the CM's

instructions in such a manner to remove all surface contamination that would be detrimental to the coating.

- ii. The surface shall then be washed with potable water with chloride content below 20ppm at high pressure e.g. 1380 kPa (200 psi) to remove the contaminated detergent or degreaser before it dries on the surface.
- iii. For SSPC-SP 16 surface preparation, a brush-off blast cleaned non-ferrous metal surface shall be free of all visible oil, grease, dirt, dust, metal oxides (corrosion products), and other foreign matter. Bare metal substrates shall have a minimum profile of 19 μm (0.75 mil).

4.3.5 Hand Preparation Methods

- i. The surface to be prepared shall be washed down with an Owner approved biodegradable alkali based detergent or degreaser applied as per the CM's instructions in such a manner to remove all surface contamination that would be detrimental to the coating.
- ii. The surface shall then be washed and rinsed with potable water containing chloride content below 20ppm to remove the contaminated detergent or degreaser before it dries on the surface.
- iii. Abrasive sand paper of rating 100-120 shall be used to achieve 100% surface suitability for the application of primer coat.
- iv. Surface shall be kept wet during the operation (using potable water) and rinsed afterwards to ensure the sanding residue does not dry on the surface to be primed.

5.0 APPLICATION

5.1 APPLICATION CONDITION

5.1.1 Coatings shall be applied to dry, clean, prepared surface under conditions recommended in the CM's product data sheet. The Contractor shall comply with the Quality Program (QP) for work execution. Where deviation may exist, it is the responsibility of the Contractor to highlight the deviations and obtain the necessary approval from Technical Authority.

5.1.2 Coatings shall not be applied when any of the following conditions exist:

- i. The surface temperature is not meeting requirement of at least 3°C above dew point.
- ii. The surface temperature is below 5°C as it could adversely affect the curing of coatings. Refer to CM product data sheet for systems that can be applied at temperatures below 5°C.
- iii. The relative humidity (RH) is greater than 85%, except for moisture-cured urethane coating systems which may be used at higher than 85% RH.
- iv. The metal surface temperature is above 50°C or higher than that recommended by the CM for application.
- v. Surface preparation has not been completed or oil, grease and dust are present on the substrate to be coated.
- vi. Poor weather conditions example rain, heavy fog or blowing sand.
- vii. When there is a deposition of moisture in the form of rain, condensation etc. on the surface. Probability of condensation may be determined in accordance with procedures described in ISO 8502-4.
- viii. Where the available light is less than 500 lux.
- ix. Coating may be suspended at the discretion of the Owner Site Representative due to wind speed, wave height, or when adverse weather conditions are likely to develop before coating could be carried out, or for other reasons deemed inappropriate to proceed.

5.1.3 It is important to ensure residual salt contamination particularly from chloride ion is kept to as minimal as possible. Contractor to agree with Owner on random residual salt test that shall be conducted for these conditions:

- i. Prior to primer application;
- ii. Subsequent coating layer application after a long interval e.g. after 1 day curing of previous coating application.

- 5.1.4 The assessment of soluble chloride ion content shall be carried out in accordance with ISO 8502-6 and 8502-9 or any approved commercial field test kit by the Owner. The soluble chloride ion limit shall be 20mg/m², except for maintenance coating works and for other than stainless steels in atmospheric zone where 50mg/m² is acceptable. The test shall be carried out once per 200 m² area with a minimum frequency of three times per shift.
- 5.1.5 If the soluble chloride ion content is high and obtaining a clean surface is too costly, the allowable soluble chloride ion content shall be agreed by the Contractor and Owner.
- 5.1.6 Other specific requirements on coating applications include:
- i. Applied coatings for offshore and onshore near marine environment shall not be left without overcoating for a period more than 3 days or the maximum over coating time recommended by the CM whichever is shorter. If this is exceeded, high pressure e.g. 1380 kPa (200 psi) fresh water washing shall be conducted prior to the application of the subsequent coats and validated with soluble chloride ion test. Product specific datasheet shall be complied, not exceeding the PTS limit.
 - ii. Applied coatings for onshore away from marine environment shall not be left without overcoating for a period of more than 14 days or the maximum over coating time recommended by the CM whichever is shorter. If this is exceeded, high pressure e.g. 1380 kPa (200 psi) fresh water washing shall be conducted prior to the application of the subsequent coats and validated with soluble chloride ion test. Product specific datasheet shall be complied, not exceeding the PTS limit.
 - iii. Zinc or aluminium in the form of coating pigments or metal spray shall never be allowed to come into contact with stainless steel, nickel-based alloys or copper-based alloys.
 - iv. Any coatings used on stainless steel, nickel based alloys and copper based alloys shall be chloride free and also free of low melting point metals such as zinc, aluminum, tin and lead.
 - v. On structural steel areas subject to be assembled by high tension bolts, contact surface shall be primed only with Inorganic Zinc Silicate. Intermediate and final coat shall not be applied.

5.2 REPAIR COATING

5.2.1 General Requirements

- i. Procedure for coating repair for each coating system shall be submitted by contractor for Owner approval.
- ii. Before application of any subsequent coating material, all damages from previous coats shall be repaired. All loose coating shall be removed to a firm edge. All surface irregularities and contaminations shall be removed. Hard, glossy surface may require abrading to obtain a suitable surface for coating. Surface preparation shall refer to Maintenance Coating requirements in APPENDIX A of this PTS.

- iii. If the prepared surface lies adjacent to a sound coated surface, the surface preparation shall overlap the coated surface by at least 50mm. The remainder of existing coated surface shall be properly protected with shields or screens to prevent any possible damage to the coating.
- iv. Inorganic Zinc primer shall not overlap adjacent intermediate and finish coats. Areas with inadequate coating thickness shall be thoroughly cleaned and if necessary, abraded, and additional compatible coats are applied until the specified thickness is met. These additional coats shall blend in with the final coating on adjoining areas.

Coating Repair Type	Coating surface condition	Rust scale (ISO 4628-3)	Surface Preparation
Surface Cleaning with Clean Rag	Contaminated, no corrosion	Ri 0 and Ri 1	-
Touch up coating	10% to 20% scattered localised corrosion with minimal exposure of substrate surface	Ri 2	SSPC-SP11
Spot repair	20% to 50% surface area corroded	Ri 3	SSPC-SP11
Repainting	More than 50% surface area corroded	Ri 4 and Ri 5	Sa 2.5

Table 5.1: Typical Maintenance Practices

6.0 RESOURCE REQUIREMENT

6.1 COATING CONTRACTOR

6.1.1 Coating contractors shall have the personnel, organisation, qualifications, procedures, knowledge and capability to produce surface preparation and coating application of the required quality. The procedure for evaluating qualifications of coating contractors is described in SSPC-QP1. Alternative certifications and qualifications may be used, subject to Owner's approval.

6.1.2 Functional areas to be evaluated shall include the following:

- i. Management Procedures: Company policy and management procedures;
- ii. Technical Capabilities: Personnel qualifications, technical resources, procedures, equipment, facilities and experience;
- iii. Quality Control: Personnel qualifications, inspection procedures and recording systems;
- iv. Safety: Safety procedure, record systems and resource materials.

Roles	Responsibilities	Qualifications	Notes
Coating/ Painting Inspector	• To ensure the coating quality is in accordance with the specification. The inspector may be required, as a minimum, to review, validate, witness, verify and document the work at various inspection points as per the ITP as per APPENDIX L. • Note that this Coating Inspector is only responsible for his area of work. Overall coating project responsibility lies with the coating advisor • Note that this role does not absolve the Coating Contractor of their overall QA/QC responsibilities. • The Coating Inspector is in charge of areas $\geq 5000\text{m}^2$ area to be coated in a single project.	• Certified with either one of below as a minimum. i. Institute of Materials Malaysia (IMM) Coating Inspector Level II ii. NACE International Certified Coating Inspector Level I iii. SSPC PCI Level I iv. FROSIO Level II • And minimum 3 years working experience in coating inspection with good working knowledge on all aspects of coating such as procedures, specification, coating performance, application and able to use coating inspection tools.	• IMM Coatings Fingerprint Quality Controller Level 1 certification is an advantage • Abseiling certification may be required
Coating/ Painting Advisor (Owner)	• To ensure the overall project coating quality is in accordance with the specification. The role of the advisor is to oversee all of the coating inspector's activities.	• Certified with either one of below as a minimum. i. Institute of Materials Malaysia (IMM) Coating Inspector Level II	• IMM Coatings Fingerprint Quality Controller Level

Roles	Responsibilities	Qualifications	Notes
	This role is an ad-hoc position by appointment given to a qualified Owner. Note that this role does not absolve the Coating Contractor of their overall QA/QC responsibilities.	ii. NACE International Certified Coating Inspector Level II iii. SSPC PCI Level II iv. FROSIO Level III • And minimum 5 years working experience in coating inspection with good working knowledge on all aspects of coating such as procedures, specification, coating performance, application and able to use coating and coating inspection tools.	1 certification is an advantage
Blasting and Coating/ Painting Supervisor	- The Blaster and Painting Supervisor assumes the overall execution of any coating activity - Shall participate in developing JSA and JHA. - Shall develop job plans and ensure adequate QC coverage based on projected schedules or minimum QC coverage by crew, structure, location, or working hours. - Able to troubleshoot any application issues and help raise MOC. - Ensure understanding of work scope, requirements of work and safety compliance among team members. - Ensure surface preparation and coating application is done properly by adherence and compliance to procedures, technique, environment, equipment setups and limitations etc. to avoid defects. - Ensure timely and quality job completion with most economical approach avoiding wastage.	• Shall be certified with either one of below as a minimum. i. IMM-SSPC C7 Abrasive Blasting Program, C12 Spray Application Program, or ii. IMM-SSPC Coating Applicator Specialist Level II • And minimum 7 years working experience in coating inspection with good working knowledge in specification and procedures. Knowledge shall include: i. Corrosion ii. Coating and Properties iii. Marine environment for coating iv. Volume of solid v. Coating defects vi. Quality control vii. Inspection viii. Safety ix. Role of Supervisor x. Human relations	Not Applicable

Roles	Responsibilities	Qualifications	Notes
	• Keep track and act upon daily progress, material consumption and ordering of stock. • Ensure equipment and material are stored according to manufacturer recommendations.		
Lead Blaster and Painter	• Shall be able to carry out the company accepted surface preparation and application of coatings safely and to the minimum required quality of this PTS. • Shall be able to work independent of any direct supervision. • Shall supervise up to a maximum of ten (10) blasters and Coating Applicator. • Shall be able to understand and apply PTW, JSA, JHA; read and apply manufacturers data sheet, MSDS and coating system sheets, coating specifications • Shall be competent and skilful with the following operations (as a minimum): - Blasting; - Equipment Set Up (Type of Nozzle, Compressor Pressure, Type of Hose, After Cooler). - Abrasive (Type, Size). - Surface Quality Achieved. - Coating; - Equipment (Application Method, Air Pressure, Tip Size) - Specialist Coatings and Linings Applications (Product used, Generic name, Mixing Ratio, Mixing Method, Thinner, Percent thinning, Expected Pot Life, Thickness required) • Lead Blaster or Painting should be capable of working effectively from scaffolding or temporary	• Shall be certified with below as a minimum. - IMM-SSPC Abarasive Blasting Program (C7) and Spray Application Program (C12), or SSPC Coating Applicator Specialist Level II • And minimum 5 years working experience in blasting and coating. • Akademi Binaan Malaysia/CIDB Certified Blasters and Painters is an advantage.	Not Applicable

Roles	Responsibilities	Qualifications	Notes
	structures and at heights up to 300m above water.		
Blaster and Painter	• Shall be able to carry out the company accepted surface preparation and application of coatings safely and to the minimum required quality of this PTS. • Shall be working under the supervision of a Lead Blaster and Painter. • Shall be competent and skilful with the following operations (as a minimum): i. Blasting; ii. Equipment Set Up (Type of Nozzle, Compressor Pressure, Type of Hose, After Cooler). iii. Abrasive (Type, Size). iv. Surface Quality Achieved. v. Coating; vi. Equipment (Application Method, Air Pressure, Tip Size) vii. Coating Used (Product used, Generic name, Mixing Ratio, Mixing Method, Thinner, Percent thinning, Expected Pot Life, Thickness required) • Blaster or Painter should be capable of working effectively from scaffolding or temporary structures and at heights up to 300m above water.	• Shall be certified with below as a minimum. i. IMM-SSPC Abarasive Blasting Program (C7) and Spray Application Program (C12) • And minimum 1 years working experience in blasting and painting. • Akademi Binaan Malaysia/CIDB Certified Blasters and Painters is an advantage.	• Abseiling certification may be required

Table 6.1: Resource Requirement

7.0 COLOUR SCHEMES

7.1 STRUCTURAL COLOUR SCHEMES

7.1.1 The colour scheme for structures shall be as per APPENDIX I.

7.2 PIPING COLOUR SCHEMES AND IDENTIFICATION SYSTEM

7.2.1 The colour scheme for piping and piping identification system shall be as per APPENDIX H.

7.2.2 For insulated and non-insulated piping identification, the product contained shall be marked by a legend specifying product name in full or abbreviated form. Arrows shall be used to indicate direction of flow. In cases where the piping changes direction or where pipe passes through walls or floors, arrows shall be placed in positions which are easily visible. As a minimum, arrows shall be placed at each location where the direction of the flow changes or prior to penetration of wall or floor.

7.2.3 Pipe marking may be done by either coating or using tapes or markers. The application of tapes for pipe identification shall be limited to 60°C for non-insulated pipe and no temperature limit for insulated pipe. The detailed dimension, location and number of markings shall be based on particular piping system as specified in APPENDIX G.

7.2.4 For systems not described in APPENDIX G, the Owner shall determine the marking as appropriate based on ANSI A13.1- "Scheme for Identification of Piping System".

7.2.5 Each line shall be labelled in English with its service and to/from designation such as "Crude to L.P Separator Train 1". The labelling shall be as short as possible, but concise. The labelling shall be applied only at the starting and termination of a line.

7.3 EQUIPMENT COLOUR SCHEME

7.3.1 The colour scheme for equipment shall be as per APPENDIX I. The storage tank identification system which includes product content and the tank number shall be as described in APPENDIX F.

7.4 PIPELINE/RISER IDENTIFICATION SYSTEM

7.4.1 Each pipeline/riser shall be marked in accordance with piping identification system as per APPENDIX G. The pipeline marking shall be easily visible.

7.4.2 The marking location shall be determined by the Owner. As a minimum, the marking should be at the beginning and end of the pipeline. For offshore pipeline, the marking can be made at the launcher to riser section and at the receiver section. For onshore above ground pipeline, the marking can be made at the pipeline section before and after the pipeline is buried.

7.5 COLOUR SCHEME FOR SAFETY EQUIPMENT AND PIPING

7.5.1 The colour scheme and marking for escape route shall be as per APPENDIX J.

8.0 BIBLIOGRAPHY

In this PTS, reference is made to the following Standards/Publications. Unless specifically designated by date, the latest edition of each Standards/Publications shall be used, together with any supplements/revisions thereto:

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PTS Requirements, General Definition of Terms, Abbreviations & Reading Guide	PTS 00.01.03
Offshore Temporary Refuges	PTS 11.20.01
Control Valves : Selection, Sizing and Specifications	PTS 14.10.04
Helidecks for Fixed and Mobile Offshore Installations	PTS 18.55.06
Safety Sign and Colour Coding	PTS 60.2002

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Factories and Machinery (Mineral Dust) Regulations 1989	FMA
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Standard Test Method for Indicating Oil or Water in Compressed Air	ASTM 4285
Standard Practice for Operating Salt Spray (Fog) Apparatus	ASTM B117
Standard Test Methods for Water Vapour Transmission of Organic Coating Films	ASTM D1653
Standard Test Method for Evaluation of Coated or Coated Specimens Subjected to Corrosive Environments	ASTM D1654

Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments	ASTM D1654
Standard Test Method for Tensile Properties of Organic Coatings	ASTM D2370
Standard Test Methods for Evaluating Coatings for High Temperature Service	ASTM D2485
Standard Test Method for Isocyanate Groups in Urethane Materials or Prepolymers	ASTM D2572
Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor	ASTM D2583
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Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel	ASTM D4417
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Standard Practice for Conducting a Patch Test to Assess Coating Compatibility	ASTM D5064
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Standard Test Method for Specular Gloss	ASTM D523
Standard Test Method for Consistency of Coatings Measuring Krebs Unit(KU) Viscosity Using a Stormer-Type Viscometer	ASTM D562
Standard Practice for Cyclic Salt Fog/UV Exposure of Coated Metal.(Alternating Exposures in a Fog/Dry Cabinet and a UV Condensation Cabinet)	ASTM D5894
Standard Guide for FT-IR Fingerprinting of a Non-Aqueous Liquid Coating as Supplied in the manufacturer's Container	ASTM D7588
Standard Practice for Testing Water Resistance of Coatings Using Water Immersion	ASTM D870

Standard Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures)	ASTM E337
Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials	ASTM G155
Standard Test Methods for Cathodic Disbonding of Pipeline Coatings	ASTM G8

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

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Procedure for Determining Conformance to Dry Coating Thickness Requirements	SSPC PA 2
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Brush-Off Blast Cleaning	SSPC-SP 7/NACE No.4
Pickling	SSPC-SP 8
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OTHER STANDARD

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APPENDIX A: COATING SYSTEM

A-1 NEW CONSTRUCTION COATING SYSTEMS

Service Category	System ID	Coat	Paint and Coating Specifications	Nominal DFT (mm)	Surface Profile (Rz, mm)
N1 Carbon Steel Atmospheric Zone (Between minus 5°C to 120°C) With/Without Insulation	N1-A (Without Insulation)	1	Inorganic Zinc Silicate Primer ^(b)	60	50-75
		2	High Solid Epoxy	150	
		3	Aliphatic Polyurethane	60	
		Total		270	
	N1-B (Without Insulation)	1	Inorganic Zinc Silicate Primer ^(b)	60	50-75
		2	Epoxy Micaceous Iron Oxide Build Coat	150	
		3	Aliphatic Polyurethane	60	
		Total		270	
	N1-C (With Insulation)	1	Inorganic Zinc Silicate Primer ^(b)	60	50-75
		2	High Solid Epoxy	150	
	Total			210	
	N1-D (With Insulation)	1	Inorganic Zinc Silicate Primer ^(b)	60	50-75
		2	Epoxy Micaceous Iron Oxide Build Coat	150	
		TOTAL		210	
N2 Carbon Steel Low Temperature Zone (Between minus 70°C to minus 5°C) Under Insulation	N2^(c)	1	Amine Cured Phenolic Epoxy	100	50-75
		2	Amine Cured Phenolic Epoxy	100	
N3 Carbon Steel (Between 120°C to 250°C)	N3-A (With Insulation)	3	Amine Cured Phenolic Epoxy	100	50-75
		Total		300	
		1	Inorganic Zinc Silicate	75	
		2	Modified Silicone Acrylic ^(d)	30	
	N3-B (Cage Type Insulation)	3	Modified Silicone Acrylic ^(d)	30	50-75
		1	Inorganic Zinc Silicate	75	
		2	Modified Silicone Acrylic ^(d)	30	
		3	Modified Silicone Acrylic ^(d)	30	
		4	Modified Epoxy	100	
		Total		235	
N4 Carbon Steel (Between 250°C to 450°C) Under Insulation	N4	1	Silicone Aluminium ^(e)	25	25-35
		2	Silicone Aluminium ^(e)	25	
		Total		50	

Service Category	System ID	Coat	Paint and Coating Specifications	Nominal DFT (mm)	Surface Profile (Rz, mm)
N5 Offshore Platform Decks Including Primary and Secondary Structures (Deck and Floors - Light or Normal Duty and Foot Traffic)	N5	1	Epoxy Universal Primer ^(t)	75	75-100
		2	Amine Cured Glass Flake Reinforced Epoxy	300	
		3	Antiskid Powder (Aluminium Oxide/ Garnet) ^(f)	-	
		4	Aliphatic Polyurethane ^(g)	60	
		Total		435	
N6 Offshore Platform Decks Including Primary and Secondary Structures (Decks and Floors - Heavy Duty, Landing Area and Helidecks)	N6	1	Epoxy Universal Primer ^(t)	75	75-100
		2	Amine Cured Glass Flake Reinforced Epoxy	300	
		3	Amine Cured Glass Flake Reinforced Epoxy	300	
		4	Antiskid Powder (Aluminium Oxide/ Garnet) ^(f)	-	
		5	Aliphatic Polyurethane ^(g)	60	
		Total		735	
N7 Carbon Steel, Galvanised Steel and Stainless Steel In Splash Zone (Up to 120°C)	N7-A Carbon Steel	1	Epoxy Universal Primer ^(t)	75	75-100
		2	Amine Cured Glass Flake Reinforced Epoxy	300	
		3	Aliphatic Polyurethane	60	
		Total		435	
	N7-B Galvanised Steel & Stainless Steel	1	Epoxy Universal Primer ^(t)	75	SSPC-SP-16
		2	Amine Cured Glass Flake Reinforced Epoxy	300	
		3	Aliphatic Polyurethane	60	
		Total		435	
N8 Carbon Steel Tidal Zone (Up to 120°C)	N8-A	1	Thermal Spray Aluminium	200	75-100
		2	Polyamide Cured Universal Epoxy (Immersion)	75	
		Total		275	
	N8-B^(h)	1	Epoxy Glass Flake ^(q)	500	75-100
		2	Epoxy Glass Flake ^(q)	500	
		Total		1000	
	N8-C^(h)	1	Polyester Glass Flake ^(q)	500	75-100
		2	Polyester Glass Flake ^(q)	500	
		Total		1000	
N9 Carbon Steel Exterior Submerged Zone, Below Low Tide Level (Up to 60°C)	N9-A^{(h) (u)} (Seawater) Interim usage	1	Epoxy Universal Primer	75	50-75
		Total		75	
	N9-B^(h) (Seawater)	1	Epoxy Universal Primer ^{(i) (t)}	150	50-75
		2	Epoxy Tie Coat	100	
		3	Non-Toxic Antifouling Coating ⁽ⁱ⁾	100	
		4	Non-Toxic Antifouling Coating ⁽ⁱ⁾	100	
		5	Non-Toxic Antifouling Coating ⁽ⁱ⁾	100	

Service Category	System ID	Coat	Paint and Coating Specifications	Nominal DFT (mm)	Surface Profile (Rz, mm)
		Total		550	50-75
		1	Epoxy Universal Primer ^(t)	75	
		2	Amine Cured Solvent Free Epoxy	150	
		3	Amine Cured Solvent Free Epoxy	150	
		Total		375	
N10 Carbon Steel Under Sweating Condition (Without Insulation)	N9-C^(h) (Fresh Water)	1	Epoxy Universal Primer ^(t)	75	50-75
		2	Amine Cured Solvent Free Epoxy	150	
		3	Amine Cured Solvent Free Epoxy	150	
	N10-A^(c)	Total		375	
		1	Amine Cured Phenolic Epoxy	100	
		2	Amine Cured Phenolic Epoxy	100	
N11 Galvanised Steel Atmospheric Zone (Between minus 50°C to 120°C)	N10-B^(c)	3	Aliphatic Polyurethane	60	
		Total		260	
		1	High Zinc Epoxy	80	
	N11^(k)	2	Aliphatic Polyurethane	60	
		Total		140	
		1	Epoxy Universal Primer ^(t)	100	
N12 Stainless Steel Atmospheric Zone (Between Minus 50°C to 200°C) With/ Without Insulation	N12-A (With Insulation, Minus 50 - 120°C)	2	Aliphatic Polyurethane	60	SSPC-SP16
		Total		160	
		1	Epoxy Universal Primer ^(t)	100	
	N12-B (With Insulation Minus 50 - 120°C)	2	Aliphatic Polyurethane	60	
		Total		200	
		1	Amine Cured Phenolic Epoxy	100	
	N12-C (Cage Type/ Without Insulation, Ambient- 120°C)	2	Amine Cured Phenolic Epoxy	100	
		3	Aliphatic Polyurethane	60	
		Total		260	
	N12-D (Cage Type/ Without Insulation 120-200°C)	1	Epoxy Primer	100	
		2	Epoxy Primer	100	
		3	Aliphatic Polyurethane	60	
N13 Stainless Steel Atmospheric Zone (Between 200°C to 450°C)	N13^(m)	1	Epoxy Primer	100	
		2	Epoxy Primer	100	
		3	Aliphatic Polyurethane	60	
	N13^(m)	Total		235	
		1	Amine Cured Phenolic Epoxy	100	
		2	Amine Cured Phenolic Epoxy	100	
	N13^(m)	3	Silicon Acrylic	35	
		Total		235	
		1	Amine Cured Phenolic Epoxy	100	
	N13^(m)	2	Amine Cured Phenolic Epoxy	100	
		3	Silicon Acrylic	35	
		Total		235	
N13 Stainless Steel Atmospheric Zone (Between 200°C to 450°C)	N13^(m)	1	Silicone Aluminium	25	SSPC-SP16
		2	Silicone Aluminium	25	
		Total		50	
	N13^(m)	1	Silicone Aluminium	25	
		2	Silicone Aluminium	25	
		Total		50	

Service Category	System ID	Coat	Paint and Coating Specifications	Nominal DFT (mm)	Surface Profile (Rz, mm)
N14 Carbon Steel Storage Tank Underside (External)	N14⁽ⁿ⁾	1	Inorganic Zinc Silicate Weldable Primer	25	25-50
		2	Modified Epoxy	250	
		Total		275	
N15 Markings ^(r)	N15	1	Aliphatic Polyurethane	60	-
N16 Living Quarters, Pressurised Building and Control Room (Interior)	N16	1	Epoxy Universal Primer	75	50-75

Table A-1: New Construction Coating System

Notes:

ID Legend:

N XX – Y e.g. N1-1

- N** New construction coating
- XX** Systems number i.e. System 1
- Y** System option i.e. two options in System N1, therefore N1-A and N1-B

- (a) Minimum volume solid for high solid epoxy shall be 75%.
- (b) Epoxy Mio Mist Coat is required to seal the Inorganic Zinc Silicate primer.
- (c) Surface preparation for Phenolic Epoxy should be Sa 2.5.
- (d) Modified Silicone Acrylic is used to prevent direct interaction of Inorganic Zinc Silicate with mineral wool and it shall be of an air-drying type.
- (e) Silicone Aluminium shall be of an air-drying type.
- (f) Antiskid powder can be applied by chicken feed sprinkle method.
- (g) Aliphatic Polyurethane (PU) is meant for color coding, marking and UV protection. Areas that do not meet this requirement, does not require PU application.
- (h) Coating system must be compatible with sacrificial anode system.
- (i) Primer shall be compatible with the selected antifouling.
- (j) Antifouling shall be applied at top 10m of the submerged zone to prevent barnacle growth.
- (k) Hot dip galvanising shall be carried out in accordance with requirement of BS 729 "*Hot dipped galvanised coatings on iron and steel articles*". A minimum of DFT of 86 micron of zinc shall be applied.
- (l) Anchor pattern of 25 micron can be achieved by degreasing with fresh clean water in accordance to SSPC-SP1 and followed by SSPC-SP16 light abraded on the surface.
- (m) The intent of coating is to protect the facilities during construction and plant outages.
- (n) This coating system shall be applied at tank bottom together with CP and Vapour Phase Corrosion Inhibitor (VCI).
- (o) For Service N13, the stainless steel surface described is for Austenitic type stainless steel. 22%Cr and 25%Cr stainless steels shall be painted in accordance to System N13 for operating temperatures $\geq 50^{\circ}\text{C}$ and $\geq 80^{\circ}\text{C}$ respectively.

- (p) For universal primer, it should be compatible with wood, concrete, plastics, composites, galvanized steel, carbon steel and stainless steel substrates. It should be overcoatable with polyamide/polyamine cured epoxies, alkyd, polyurethanes, solvent free epoxies and vinyl coatings. It should be suitable for wet blast cleaned surfaces (damp/dry). It should be compatible with existing aged coatings.
- (q) Refer APPENDIX D and O for glass flake specification.
- (r) Pre-coiled wrap-around pipe markers can be used for insulated piping, up to 8" diameter. Strap-on carrier type pipe marking can be used for larger diameters for insulated and non-insulated piping.
- (s) The temperature described in Table A-1, New Construction Coating Systems shall be of design temperature.
- (t) Pure or modified epoxy universal primer can be used.
- (u) System N9-A is meant for shop primer.

A-2 MAINTENANCE COATING SYSTEMS

Service Category	System ID	Coat	Paint and Coating Specifications	Nominal DFT (mm)	Surface Profile (Rz, mm)
M1 Carbon Steel Atmospheric Zone (Between minus 5°C to 120°C) With/Without Insulation	M1-A (Spot Repair During Construction, Without Insulation)	1	Surface Tolerant Epoxy	125	SSPC-SP11
		2	Surface Tolerant Epoxy	125	
		3	Aliphatic Polyurethane	60	
		Total		210	
	M1-B ^(b) (Touch-up During Shutdown, Without Insulation)	1	Single-pack Moisture Curing Zinc Primer	70	SSPC-SP11
		2	Single-pack Moisture Curing Zinc Primer	70	
		3	Aliphatic Polyurethane	60	
		Total		200	
	M1-C (Spot Repair During Online Application, With Insulation)	1	Epoxy Universal Primer	75	SSPC-SP11
		2	Epoxy Micaceous Iron Oxide Build Coat	150	
		Total		225	
	M1-D (Touch-up With Insulation)	1	Single-pack Moisture Curing Zinc Primer	70	SSPC-SP11
		2	Single-pack Moisture Curing Zinc Primer	70	
		Total		140	
	M1-E (Blast cleaned surface area)	1	Zinc Rich Epoxy	75	50-75
		2	High Solid Epoxy	150	
		3	Aliphatic Polyurethane	60	
		Total		285	
M2 Carbon Steel Cryogenic Zone (Between minus 70°C to minus 5°C) Under Insulation	M2 ^{(c) (d)}	1	Amine Cured Phenolic Epoxy	100	50-75
		2	Amine Cured Phenolic Epoxy	100	
		3	Amine Cured Phenolic Epoxy	100	
		Total		300	

Service Category	System ID	Coat	Paint and Coating Specifications	Nominal DFT (mm)	Surface Profile (Rz, mm)	
M3 Carbon Steel Atmospheric Zone (Between 120°C to 250°C) With/Without Insulation	M3-A (Blast cleaned surface area)	1	Inorganic Zinc Silicate	75	50-75	
		2	Modified Silicone Acrylic ^(e)	30		
	3	Modified Silicone Acrylic ^(e)	30	SSPC-SP11		
	Total		135			
M4 Carbon Steel (Between 250°C to 450°C) Under Insulation	M3-B ^(f) (Touch up)	1	Modified Silicone Acrylic	30	SSPC-SP11	
		2	Modified Silicone Acrylic	30		
	Total		60	25-35		
	M4	1	Silicone Aluminium		25	25-35
2		Silicone Aluminium	25			
Total		50	50-75			
M5 Offshore Platform Decks Including Primary and Secondary Structures (Deck and Floors - Light or Normal Duty and Foot Traffic)	M5	1		Epoxy Universal Primer ^(m)	75	50-75
		2		Amine Cured Glass Flake Reinforced Epoxy	300	
		3		Antiskid Powder (Aluminium Oxide/ Garnet) ^(g)	-	
		4	Aliphatic Polyurethane ^(h)	60		
Total		435	50-75			
M6 Offshore Platform Decks Including Primary and Secondary Structures (Decks and Floors - Heavy Duty, Landing Area and Helidecks)	M6	1		Epoxy Universal Primer ^(m)	75	50-75
		2		Amine Cured Glass Flake Reinforced Epoxy	300	
		3		Amine Cured Glass Flake Reinforced Epoxy	300	
		4		Antiskid Powder (Aluminium Oxide/ Garnet) ^(g)	-	
		5		Aliphatic Polyurethane ^(h)	60	
Total		735	50-75			
M7 Carbon Steel, Galvanised Steel and Stainless Steel Splash Zone (Up to 120°C)	M7-A Carbon Steel	1		Epoxy Universal Primer ^(m)	75	50-75
		2		Amine Cured Glass Flake Reinforced Epoxy	300	
		3		Aliphatic Polyurethane ^(k)	60	
	Total		435	SSPC-SP16		
M7-B Galvanised Steel & Stainless Steel	1	Epoxy Universal Primer ^(m)	75		SSPC-SP16	
	2	Amine Cured Glass Flake Reinforced Epoxy	300			
	3	Aliphatic Polyurethane ^(k)	60			
Total		465	-			
M8 Carbon Steel, Tidal Zone (Up to 120°C)	M8	-		Retrofitted shielding ⁽ⁿ⁾	-	

Service Category	System ID	Coat	Paint and Coating Specifications	Nominal DFT (mm)	Surface Profile (Rz, mm)
M9 Carbon Steel Exterior Submerged Zone, Below Low Tide Level (Up to 60°C)	M9-A (Seawater)	1	Underwater Curable Epoxy	200	SSPC-SP WJ-1
		2	Underwater Curable Epoxy	200	
		3	Underwater Curable Epoxy	200	
		4	Underwater Curable Epoxy	200	
		Total			800
	M9-B (Fresh water)	1	Underwater Curable Epoxy	200	SSPC-SP WJ-1
		2	Underwater Curable Epoxy	200	
			Total		
M10 Carbon Steel Under Sweating Condition (Without Insulation)	M10 ^(d)	1	Amine Cured Phenolic Epoxy	100	50-75
		2	Amine Cured Phenolic Epoxy	100	
		3	UV Durable Modified Epoxy/ Single Pack Moisture Cured Urethane	60	
		Total			
M11 Galvanised Steel Atmospheric Zone (Between minus 50°C to 120°C)	M11 ⁽ⁱ⁾	1	Epoxy Universal Primer ^(m)	100	SSPC- SP16
		2	Aliphatic Polyurethane	60	
		Total			
M12 Stainless Steel Atmospheric Zone (Between Minus 50°C to 200°C)	M12-A With Insulation	1	Amine Cured Phenolic Epoxy	100	SSPC- SP16
		2	Amine Cured Phenolic Epoxy	100	
		Total			
	M12-B (With Insulation Minus 50 - 120°C)	1	Epoxy Primer	100	
		2	Epoxy Primer	100	
		Total			
	M12-C (Cage Type/ Without Insulation, Ambient- 120°C)	1	Epoxy Primer	100	
		2	Epoxy Primer	100	
		3	Aliphatic Polyurethane	60	
		Total			
M12-D (Cage Type/ Without Insulation 120-200°C)	1	Amine Cured Phenolic Epoxy	100		
	2	Amine Cured Phenolic Epoxy	100		
	3	Silicon Acrylic	35		
Total			235		
M13 Stainless Steel (Between 200°C to 450°C) With/Without Insulation	M13	1	Silicone Aluminium	25	SSPC- SP16
		2	Silicone Aluminium	25	
		Total			

Service Category	System ID	Coat	Paint and Coating Specifications	Nominal DFT (mm)	Surface Profile (Rz, mm)
M14 Markings ^(l)	M14	1	Aliphatic Polyurethane	60	-
M15 Living Quarters, Pressurised Building and Control Room (Interior)	M15	1	Epoxy Universal Primer	75	25-50

Table A-2: Maintenance Coating System

Notes:

ID Legend:

M XX – Y e.g. M1-1

M Maintenance coating

XX Systems number i.e. System 1

Y System option i.e. three options in System M1, therefore M1-A, M1-B and M1-C

- (a) Temperatures described Table A-2, Maintenance Coating Systems are operating temperature whereby evident operating experiences have been established and such that operating limits shall not exceed the range described. In case of operating conditions shall be as per design limit, then Table A-1, New Construction Coating Systems shall be referred.
- (b) Touch up area should be approximately 100cm² size and Ri3.
- (c) Coating application shall only be done during system offline (shutdown or turnaround).
- (d) Surface preparation for Phenolic Epoxy should be Sa 2.5.
- (e) Modified Silicone Acrylic is used to prevent direct interaction of Inorganic Zinc Silicate with mineral wool and it shall be of an air-drying type.
- (f) Applicable for hand-tool application.
- (g) Antiskid powder can be applied by chicken feed sprinkle method.
- (h) Aliphatic Polyurethane (PU) is meant for color coding, marking and UV protection. Areas that do not meet this requirement, does not require PU application.
- (i) For touch-up painting, cold galvanization can be done using single pack moisture curing zinc rich epoxy primer.
For universal primer, it should be compatible with wood, concrete, plastics, composites, galvanized steel, carbon steel and stainless steel substrates. It should be overcoatable with polyamide/polyamine cured epoxies, alkyd, polyurethanes, solvent free epoxies and vinyl coatings. It should be suitable for wet blast cleaned surfaces (damp/dry). It should be compatible with existing aged coatings.
- (j) SSPC-SP11 recommend to use with Sparkless grinding tool (e.g. RUST ATEX or equivalent).
- (k) Maximum temperature during application is 60°C.
- (l) Pre-coiled wrap-around pipe markers can be used for insulated piping, up to 8" diameter. Strap-on carrier type pipe marking can be used for larger diameters for insulated and non-insulated piping.
- (m) Pure or modified epoxy universal primer can be used.
- (n) For carbon steel in tidal zone, retrofitted shielding is proposed.

A-3 INTERNAL LINING SYSTEMS

Service Category	System ID	Coat	Paint and Coating Specifications	Nominal DFT (μm)	Surface Profile (Rz, μm)
L1 Hydrocarbon Bottom Plate (Between 60°C to 160°C)	L1-1 Sweet/ Sour Crude Oil, Condensate, Diesel	1	Amine Cured Solvent Free Novolac/Phenolic Epoxy	300	75-100
		2	Glass Fiber Reinforced Matting	-	
		3	Amine Cured Solvent Free Novolac/Phenolic Epoxy	300	
	Total			600	
	L1-2 Sweet/ Sour Crude Oil, Condensate, Diesel	1	Epoxy Primer	50	75-100
		2	Epoxy Glassflake	200	
		3	Epoxy Glassflake	200	
	Total			450	
L2 Hydrocarbon • Shell 1.8m height from bottom • Top 2 shell course for floating roof tank • Roof underside for fixed roof tank (Between 60°C to 160°C)	L2 Sweet/ Sour Crude Oil, Condensate, Diesel	1	Amine Cured Solvent Free Novolac/Phenolic Epoxy	300	75-100
		2	Amine Cured Solvent Free Novolac/Phenolic Epoxy	300	
	Total			600	
L3 Hydrocarbon Wet Gas, Kerosene / Jet A1, Light slop, Gasoline, naphtha (Up to 60°C)	L3 100% Internally Coated	1	Pure Epoxy Universal Primer	75	75-100
		2	Amine Cured Solvent Free Novolac/Phenolic Epoxy	300	
	Total			375	
L4 Chemical Ethanol, Methanol, Perchloroethalyne, Amine and MTBE, Rich Glycol, Ammonia (Up to 250°C)	L4 100% Internally Coated	1	Amine Cured Phenolic Epoxy	100	50-75
		2	Amine Cured Phenolic Epoxy	100	
		3	Amine Cured Phenolic Epoxy	100	
	Total			300	
L5 Chemical (Stainless Steel) Corrosion Inhibitor, Biocide, Scale Inhibitor, Oxygen Scavenger, Demulsifier, Pour Point Depressant and Surfactant (Up to 60°C)	L5		Not required	-	-
		Total		-	

Service Category	System ID	Coat	Paint and Coating Specifications	Nominal DFT (μm)	Surface Profile (Rz, μm)
L6 Water Produced Water/ Formation Water (Up to 60°C)	L6	1	Glass Flake Vinyl Ester	300	75-100
		2	Glass Flake Vinyl Ester	350	
		3	Glass Flake Vinyl Ester	350	
		Total		1000	
L7 Water Seawater and Ballast Water (Up to 60°C)	L7	1	Amine Cured Solvent Free Glass Flake Reinforced Epoxy	200	75-100
		2	Amine Cured Solvent Free Glass Flake Reinforced Epoxy	200	
		Total		400	
L8 Water Potable Water (Up to 60°C)	L8 100% Internally coated	1	Pure Epoxy Universal Primer	75	75-100
		2	Amine Cured Solvent Free Epoxy	300	
		Total		375	
L9 Water Demin/ Distilled Water (Up to 60°C)	L9 100% Internally coated	1	Pure Epoxy Universal Primer	75	75-100
		2	Amine Cured Solvent Free Novolac/Phenolic Epoxy	300	
		Total		375	
L10 Water Cold Steam Condensate and Boiler Feed Water, Sewage Water, Firewater (Up to 100°C)	L10 100% Internally coated	1	Amine Cured Phenolic Epoxy	100	50-75
		2	Amine Cured Phenolic Epoxy	100	
		3	Amine Cured Phenolic Epoxy	100	
		Total		300	
L11 Utility Utility Air/ Plant Air (Up to 100°C)	L11 100% Internally coated	1	Pure Epoxy Universal Primer	75	75-100
		2	Amine Cured Solvent Free Novolac/Phenolic Epoxy	200	
		Total		275	

Table A-3: Internal coating systems

Notes:

ID Legend:

L XX Y e.g. L10-1

L Internal coating **XX** System number i.e. System 1

Y System option i.e. three options in System L10, therefore L10A, L10B and L10C.

APPENDIX B: COATING SYSTEM PRODUCT APPROVAL REQUIREMENTS

B1 TEST PANELS

- B1.1 One (1) set of test panels shall be prepared for each generic coating system as per the various ASTM test requirements listed in the table in section 6.5.2; depending on the types of tests to be carried out.
- B1.2 The test panels shall be prepared in the field, for example in a coastal fabrication yard, to simulate field application conditions where adverse climatic conditions may prevail. Each test panel shall be surface cleaned and coated to the requirement as prescribed in this specification.
- B1.3 All test panels shall be kept indoors for a period of seven (7) days for curing before any testing.

B2 LABORATORY TESTING

- B2.1 The test panels shall be submitted to an approved third party testing agency for laboratory testing.
- B2.2 Recommended laboratory test methods shall include, but not limited, to the following:

Type	Test Method	Purpose	Acceptance Criteria
Salt Spray (Scribed)	ASTM B117 ASTM D1654 (Proc. A)	To study the creep resistance of Flawed coatings under accelerated conditions of the corrosive environment	Blast Cleaned Surface: Coating defects after 3,000 hours exposure is as per ASTM D 1654 Proc. A, Rating 4-5 at scribe Power Tool Cleaned Surface: Coating defects after 3,000 hours exposure is as per ASTM D 1654 Proc. A, Rating 3 at scribe
Salt Spray (Unscribed)	ASTM B117 ASTM D1654 (Proc. B)	To observe the performance of coatings subject to accelerated conditions of the corrosive environment	Coating defects after 4,500 hours exposure are as per ASTM D1654 Proc. B, area failed Rating No.9
Adhesion	ASTM D4541	To give a quantitative indication on the adhesion properties of the coating systems with DFT > 200μ	Splash Zone: 500 psi Atmospheric Zone: 300 psi - Test shall be conducted after 7 days cured period from the final coat
	ASTM D3359, Test Method A	To give a quantitative indication on the adhesion properties of the coating systems with DFT < 200μ	For ASTM D3359 Method A, the acceptance criteria is 3A

Type	Test Method	Purpose	Acceptance Criteria
Impact	ASTM D2794	To give a quantitative indication of the ability of coatings to resist cracking due to impact loading	18 J (Intrusion)
Water Immersion	ASTM D870	To assess the water resistance capability of a coating by partial or complete immersion of coated specimens in distilled or demin water at ambient or elevated temperatures.	6,000 hours without any visible coating defects
Abrasion	ASTM D4060	To assess quantitatively the abrasion resistance of the coatings	150mg for 1000 cycles at 1kg load using wheel CS10
Cathodic Disbonding	ASTM G8	To assess resistance of coating to Cathodic disbondment	Less than 10 mm disbondment
Accelerated Weathering	ASTM G155	To study the effects of weather on coatings	2,000 hours exposure without any coating defects (except a maximum degree of chalking rate of 6)
Heat-Resistance	ASTM D2485, Test Method B	- To evaluate the heat-resistant properties of coatings designed to protect steel surfaces exposed to elevated temperatures during their service life. Requirement: Gradual increase in temperature to the requirement. Cool down the panel to room temperature before performing salt spray test for 24hr	Surface without coating defect such as rust, blister and loss of adhesion
Cyclic Salt Fog and UV Exposure	ASTM D5894	- To observe the performance of coatings subject to accelerated conditions of the cyclic corrosion and UV exposure. Requirement: - Salt Spray duration 72 hours - Drying in air duration 16 hours - UV-A 340 nm duration 80 hours 25 cycles at 168 hours per cycle	Coating defects after 4,200 hours exposure are as per ASTM D1654 Proc. B, area failed Rating No. 9.

Table B-1: Recommended Laboratory Tests for Coating Qualification

Note: Users may select ASTM D5894 test method to replace ASTM B117, ASTM D1654 and ASTM G26.

NEW CONSTRUCTION COATING TEST MATRIX										
Process Service	System ID	Salt Spray	Cyclic Salt Fog/UV Exposure	Adhesion	Impact	Abrasion	Water Immersion	Cathodic Disbonding	Accelerated Weathering	Heat Resistance
N1	N1-A	Y	Y	Y		Y			Y	
	N1-B	Y		Y					Y	
N2	N2	Y		Y						
N3	N3			Y						Y
N4	N4			Y						Y
N5	N5	Y	Y	Y	Y	Y ^(a)			Y	
N6	N6	Y	Y	Y	Y	Y ^(a)			Y	
N7	N7	Y	Y	Y	Y	Y	Y	Y	Y	
N8	N8-A	Y		Y	Y	Y	Y	Y	Y	
	N8-B	Y		Y	Y	Y	Y	Y	Y	
	N8-C	Y		Y	Y	Y	Y	Y	Y	
N9	N9-A	Y		Y			Y	Y		
	N9-B	Y		Y ^(c)			Y	Y		
	N9-C	Y		Y			Y	Y		
N10	N10	Y	Y	Y			Y		Y	
N11	N11	Y		Y					Y	
N12	N12	Y		Y					Y	
N13	N13			Y						Y
N14	N14			Y			Y	Y		
N15	N15			Y		Y				
N16	N16			Y						

Table B-2: New Construction Coating Test Matrix for Coating Qualification

Note:

- (a) Abrasion test is only for polyurethane coating.
- (b) Polyurethane top coated coating systems for testing shall be measured for "glossiness" and colour retention using Specular Excluded (SPEX) method at 60° angle (Specular Reflectance) depicted in ASTM D523.
- (c) Adhesion test should be tested after application of second layer.

MAINTENANCE COATING TEST MATRIX										
Process Service	System ID	Salt Spray	Cyclic Salt Fog/UV Exposure	Adhesion	Impact	Abrasion	Water Immersion	Cathodic Disbonding	Accelerated Weathering	Heat Resistance
M1	M1-A	Y	Y	Y		Y			Y	
	M1-B	Y	Y	Y		Y			Y	
	M1-C	Y		Y					Y	
	M1-D	Y		Y					Y	
M2	M2	Y		Y						
M3	M3-A			Y						Y
	M3-B			Y						Y
M4	M4			Y						Y
M5	M5	Y	Y	Y	Y	Y ^(a)			Y	
M6	M6	Y	Y	Y	Y	Y ^(a)			Y	
M7	M7	Y	Y	Y	Y	Y	Y	Y	Y	
M8	M8	Y		Y	Y	Y	Y	Y	Y	
M9	M9-A	Y		Y			Y	Y		
	M9-B	Y		Y			Y	Y		
	M9-C	Y		Y			Y	Y		
M10	M10	Y	Y	Y			Y		Y	
M11	M11	Y		Y					Y	
M12	M12	Y		Y					Y	
M13	M13			Y						Y
M14	M14			Y		Y				
M15	M15			Y						

Table B-3: Maintenance Coating Test Matrix for Coating Qualification

Note:

- (a) Abrasion test is only for polyurethane coating.
- (b) Polyurethane top coated coating systems for testing shall be measured for "glossiness" and colour retention using Specular Excluded (SPEX) method at 60° angle (Specular Reflectance) depicted in ASTM D523.

INTERNAL LINING TEST MATRIX										
Process Service	System ID	Salt Spray	Cyclic Salt Fog/UV Exposure	Adhesion	Impact	Abrasion	Water Immersion	Cathodic Disbonding	Accelerated Weathering	Heat Resistance
L1	L1-A	Y		Y			Y			
	L1-B	Y		Y			Y			
L2	L2	Y		Y			Y			
L3	L3			Y			Y			
L4	L4			Y			Y			
L5	L5			Y			Y			
L6	L6	Y		Y			Y			
L7	L7	Y		Y			Y			
L8	L8			Y			Y			
L9	L9			Y			Y			
L10	L10			Y			Y			
L11	L11			Y						

Table B-4: Internal Lining Test Matrix for Coating Qualification

APPENDIX C: COATING FINGERPRINT CERTIFICATE FOR 2-COMPONENT INTERMEDIATE MATERIALS OF POLYMERIC COATINGS

Company name:		Country:			
Section 1: General information					
Product name:		Product type:	e.g. epoxy, polyurethane, polyester, inorganic zinc, epoxy zinc, etc.		
Date of issue:	Base material (e.g. epoxy / epoxy zinc / polyacrylate / polyester / inorganic zinc)		Curing agent / hardener (e.g. amine / isocyanate / peroxide / ethyl-silicate)		
Specify base material & curing agent	e.g. epoxy		e.g. amine		
Trade name					
Generic					
Factory location					
Batch number					
Production date					
Shelf life					
Section 2: Test Methods and Results					
	Section 2A: Physical analyses				
Parameters	Method	Specification (state method used)	Result	Specification	Result
Viscosity	e.g. ASTM D4287 ASTM D5125 ASTM D562 ISO 2431 ISO 2884-1				
Density	e.g. ISO 2811-4				
Colour code	e.g. BS 4800 OSHA				
Non-volatile matter (by mass)	e.g. ISO 3251				
Weight Solid: Zn metal/Total Zn Note: submit certificate of % purity by manufacturer Note: applicable to organic and inorganic zinc only	e.g. ISO14680-2				

Section 2B: Structural analysis					
Infrared spectra	Wet sample as supplied in can. Matching criteria ≥ 0.90				
	Std. Ref.	Base		Hardener	
Base material: epoxy Curing agent: amine	ASTM D7588	600-4000 cm^{-1}		600-4000 cm^{-1}	
	ASTM D7588	1000-1300 cm^{-1}		1000-1400 cm^{-1}	
	ASTM D7588	700-900 cm^{-1}		N/A	N/A
Base material: polyacrylate / polyester Curing agent: isocyanate	ASTM D7588	600-4000 cm^{-1}		600-4000 cm^{-1}	
	ASTM D7588	1600-1800 cm^{-1}		2000-2500 cm^{-1}	
	ASTM D7588	3000-3800 cm^{-1}		3000-3800 cm^{-1}	
Base material: polyester Curing agent: peroxide	ASTM D7588	600-4000 cm^{-1}		600-4000 cm^{-1}	
	ASTM D7588	1600-1800 cm^{-1}		900-1200 cm^{-1}	
	ASTM D7588	2700-3100 cm^{-1}		N/A	N/A
Base material: epoxy zinc Curing agent: amine	ASTM D7588	600-4000 cm^{-1}		600-4000 cm^{-1}	
	ASTM D7588	1000-1300 cm^{-1}		1000-1400 cm^{-1}	
	ASTM D7588	700-900 cm^{-1}		N/A	N/A
Base material: inorganic zinc Curing agent: ethyl-silicate	ASTM D7588	600-4000 cm^{-1}		600-4000 cm^{-1}	
	ASTM D7588	N/A	N/A	2700-3200 cm^{-1}	
	ASTM D7588	N/A	N/A	1000-1500 cm^{-1}	
Section 3: FTIR test details (as per ASTM D7588)					
Analyst & company name					
Brand & model of FTIR					
Benchtop: ATR crystal material	e.g. diamond, zinc selenide (ZnSe), zinc sulfide (ZnS), germanium				
Spectral correction Note: correction is NOT recommended.	YES / NO e.g. automatic baseline correction				
Spectral range (cm^{-1})	e.g. 600-4000 cm^{-1}				
No. of sample scans (min 32)	e.g. 32 scans				
Resolution (min 4 cm^{-1})	e.g. 4 cm^{-1}				
Correlation search algorithm for matching % in absorbance mode	Note: Correlation search algorithm of the FTIR software must depend on both x - (wavenumber) and y - (absorbance) vectors.				
	Dependence on x -vector (wavenumber / cm^{-1})	YES / NO	Dependence on y -vector (absorbance / a.u.)	YES / NO	
Trade name and batch number of reference spectrum for base material					
Trade name and batch number of reference spectrum for curing agent / hardener					

Notes:

1. Full range of FTIR spectra for both base and curing agent without automatic baseline correction and in absorbance mode are to be attached with this report (raw data).
2. Compliance to matching criteria values do not exclude meeting the requirements of other QA/QC checks e.g. drying time, gloss, hiding power etc.
3. Methods used shall reference latest published document.

Authorized QA/QC Executive:	Validated by:
	
Signature:	Signature:
Date:	Date:
	IMM membership member:

Section 4: Compulsory appendices (to be submitted in CD or other digital format)	
Appendix 1	Overlay reference and sample FTIR spectra for base materials (Note: In addition, raw data of reference and sample FTIR spectra must be provided in two raw data files)
Appendix 2	Overlay reference and sample FTIR spectra for curing agent / hardener (Note: In addition, raw data of reference and sample FTIR spectra must be provided in two raw data files)
Appendix 3	Relevant MSDS
Appendix 4	Certificate of analyses which are relevant to the in-house standard testings
Appendix 5	Certificate of % purity of zinc by metal manufacturer for organic zinc and inorganic zinc

APPENDIX D: POLYESTER GLASS FLAKE GENERIC SPECIFICATION

D1 GENERAL

- D1.1 This specification establishes the minimum requirements of a glassflake filled polyester coating which is recommended for topsides and splash zone areas.
- D1.2 Type of Polyester: The polyester resin shall be either Bisphenol A or Isophthalic.
- D1.3 Wax-free coating is preferred. Where wax layers are unavoidable, the wax content shall be as low as possible with maximum limit of 0.1% (wt).

D2 GLASS FLAKES REQUIREMENTS

- D2.1 The glassflakes used shall be of the chemical resistance type (Type C). The minimum glassflake content shall be 20% by weight. However, the percentage of glass loading can be variable without compromising the system performance with respect to water resistance during immersion and its acceptance shall be based on the results of a successful qualification test.
- D2.2 The maximum thickness of the glassflake shall be 5 ± 2 microns. The glassflake particles shall be of 20 microns to 400 microns in any one direction of the planer surface. A maximum of 4% may be allowed outside the above range. Extenders such as silica flour, mica or talc shall not be used.
- D2.3 The glassflake is an added product to give a low permeability. Therefore, the maximum permeability should be 0.015 perm cm (0.0006 perm inches) measured in accordance with ASTM D1653.

D3 OTHER REQUIREMENTS

- D3.1 The product shall be capable of being applied in one single coat through wet to wet technique by airless spray up to a thickness of 800 microns at a temperature of up to 35 °C without "curtains".
- D3.2 The product shall have a volume solid of 95% minimum.
- D3.3 The pigment content shall be maximum 3.5% by weight of the resin component. If required, the manufacturer may add UV stabiliser provided the above maximum is adhered to.
- D3.4 The shelf life of the base product shall be 6 months minimum at a temperature of 35°C when not stored in direct sunlight. The MEK peroxide shall be stored at a temperature of maximum 30 °C. The pot life shall be 30 minutes minimum at a temperature of 23 °C.
- D3.5 The final product shall be dry to touch within one hour and dry to walk on within three hours at a temperature of 35 °C.
- D3.6 The Barcol hardness shall be within the range of 35 – 45 as measured in accordance with ASTM D2583.

- D3.7 Safety: The CM shall provide the Owner and the relevant applicator with a valid Materials Safety Data Sheets (MSDS).

D4 TEST METHODS AND ACCEPTANCE CRITERIA

- D4.1 Abrasion Resistance: The maximum loss in weight shall be below 150 mg when using a Taber Abrasion Tester with a CS-10 wheel, a 1 kg load applied for 1000 cycles.
- D4.2 Salt Spray Test: The coating shall be able to withstand a salt spray test according to ASTM B117 for 10,000 hours without showing a coating failure.
- D4.3 Immersion: The coating shall be able to withstand immersion in sea water and distilled water according to ASTM D870-92, test for 6,000 hours at ambient temperature without showing a coating failure such as blistering, loss of adhesion, softening, or embrittlement.
- D4.4 Cathodic Disbondment Test: The coating shall pass a cathodic disbondment resistant test (<10 mm disbondment) in accordance with ASTM G8 at a potential of -1450 mV (against Ag/Ag Cl) at 30° C.
- D4.5 **Other Properties:** A good flexibility of the product is required for the coating to be able to withstand mechanical damage. The required properties shall be with minimum requirement of:
- i. Tensile strength (test speed 50 mm/min) - 30 N/mm²
 - ii. Elongation - 0.9 %
 - iii. The coefficient of thermal expansion shall be in the same order as that of steel i.e. between $10-90 \times 10^{-6} / ^\circ \text{C}$.

APPENDIX E: EPOXY GLASS FLAKE GENERIC SPECIFICATION

E1 GENERAL

- E1.1 This specification establishes the minimum requirements of an epoxy glassflake filled coatings recommended for topsides and splash zone areas. The required dry film thickness shall be 800 microns.
- E1.2 Type of Epoxy: The epoxy resin will be based on liquid epoxy.

E2 GLASS FLAKES REQUIREMENTS

- E2.1 The glassflake used shall be of the chemical resistance type 'C' glass. The minimum content shall be 10% by weight.
- E2.2 The minimum thickness of the glass flake shall be 5 ± 2 microns with an average length of 400 microns in any direction of the planner surface. However, the percentage of glass loading can be variable without a compromise on system performance with respect to water resistance during immersion; and its acceptance shall be based on the results of a successful qualification test.
- E2.3 The glassflake is an added product to give a low permeability. Therefore, the maximum permeability should be 0.015 perm cm (0.0006 perm inches) measured in accordance with ASTM D1653.

E3 OTHER REQUIREMENTS

- E3.1 Spray Application: The product is high in viscosity and it is necessary to ensure all equipment is in good working order before attempting to apply. Pump should have a minimum ratio of 45:1. Filters should be removed to avoid filtering out glass flake. It also advisable to check that adequate air volume is present, otherwise a consistent spray fan will not be obtained.
- E3.2 Volume Solids: The product should have a minimum volume solids of 90%.
- E3.3 Shelf Life/Pot Life: The shelf life of this product shall be 6 months minimum at a temperature of 35°C when not stored in direct sunlight. The pot life shall be 30 minutes at a temperature of 23°C.
- E3.4 Drying Times: The product shall hard dry within 4 to 10 hours at temperature range of 25° to 40° C.
- E3.5 The Barcol hardness shall be within the range of 40 – 50 as measured in accordance with ASTM D2583. (Model GYZJ 935)
- E3.6 Safety: The CM shall provide the Owner and the relevant applicator with a valid MSDS.

E4 TEST METHODS AND ACCEPTANCE CRITERIA

- E4.1 Abrasion Resistance: The maximum loss in weight shall be below 150 mg when using a Taber Abrasion Tester with a CS-10 wheel, a 1 kg load applied for 1000 cycles.
- E4.2 Salt Spray Test: The coating shall be able to withstand a salt spray test according to ASTM B117 for 10,000 hours without showing a coating failure.
- E4.3 Immersion: The coating shall be able to withstand immersion in sea water and distilled water according to ASTM D870-92 test for 6,000 hours at ambient temperature without showing a coating failure such as blistering, loss of adhesion, softening, or embrittlement.
- E4.4 Cathodic Disbondment Test: The coating shall pass a cathodic disbondment resistant test (<10 mm disbondment) in accordance with ASTM G8 at a potential of -1450 mV (against Ag/Ag Cl) at 30° C.
- E4.5 Other Properties required to achieve good mechanical properties are as follows:
- i. Tensile Strength (ASTM D2370) - 10 M Pa (1450 psi.)
 - ii. Elongation (ASTM D2370) - 2%
 - iii. The coefficient of thermal expansion shall be in the same order as that of steel i.e. between $10-90 \times 10^{-6} / ^\circ \text{C}$.

APPENDIX F: STORAGE TANK IDENTIFICATION SYSTEM

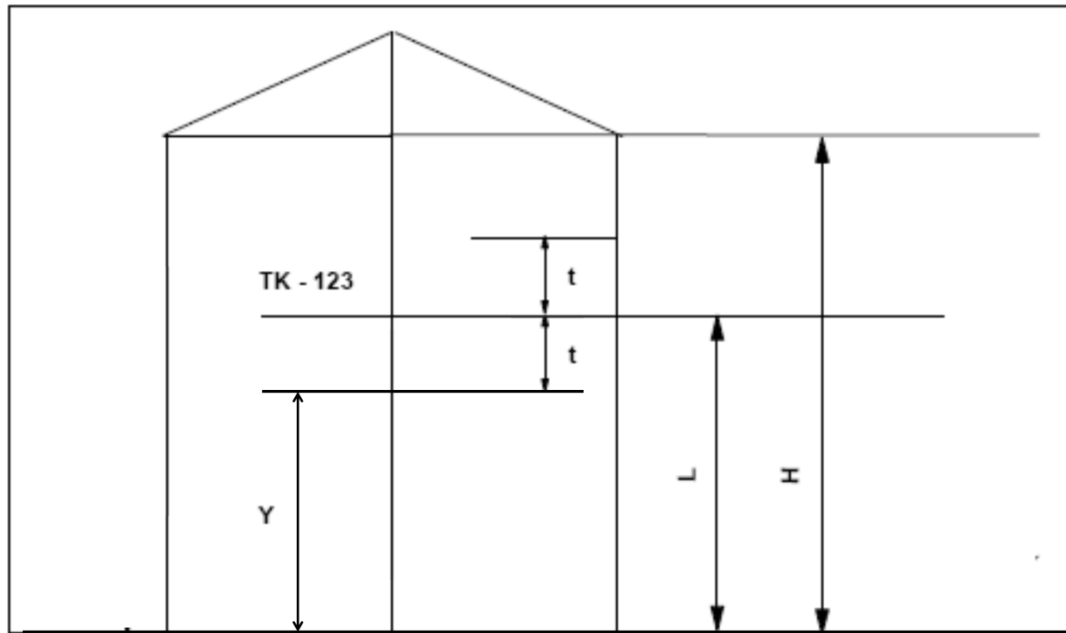


Figure F-1: Location of item number and size of lettering for storage tank

$H = \text{Tank Height}$

$$Y = \frac{2}{3}H - t \text{ or } \frac{1}{2}H$$

$$L = \frac{2}{3}H$$

$$t = \frac{1}{12}H$$

Lettering: Black

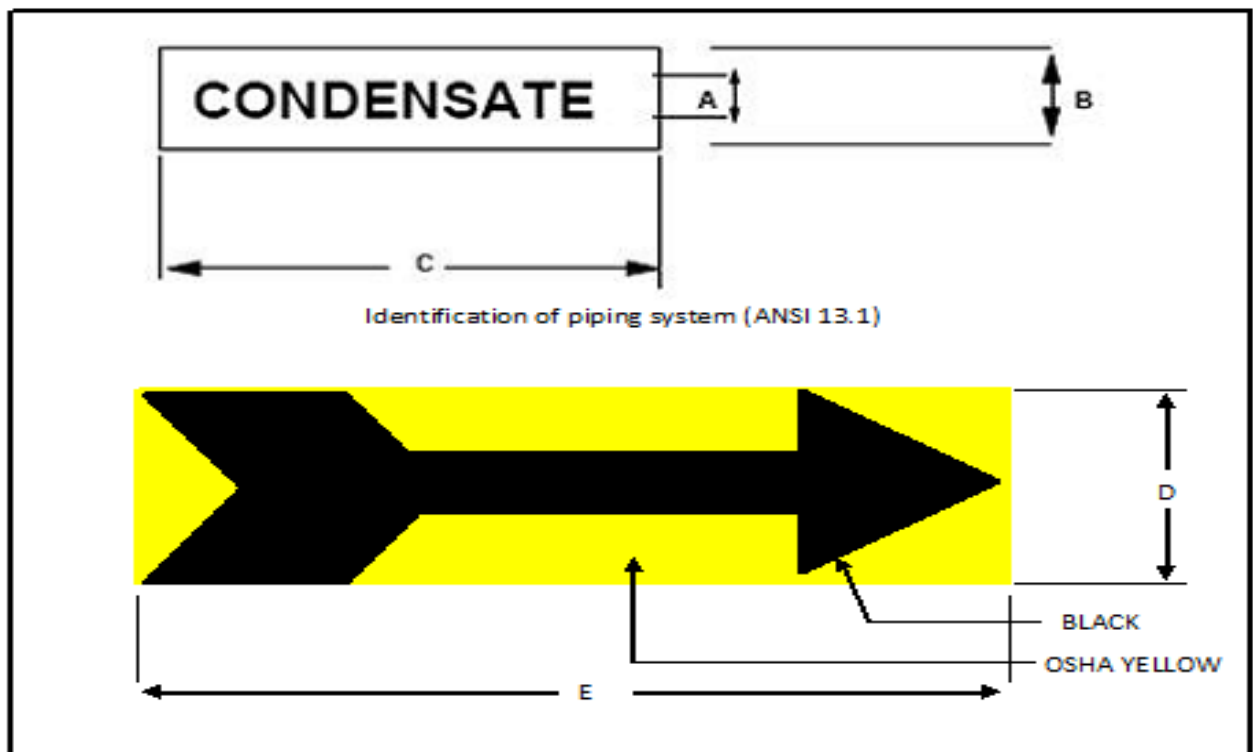
Location: Fixed at field

APPENDIX G: PIPING IDENTIFICATION SYSTEM

G1 PIPING IDENTIFICATION MARKING

TYPE	PIPE O.D. (in)	IDENTIFICATION LEGEND			FLOW DIRECTION ARROW	
		A, in	B, in	C, in	D, in	E, in
1	0.75 – 1.25	0.5	0.75	8.00	0.75	4.00
2	1.50 – 2.00	0.75	1.00	8.00	1.00	5.00
3	2.50 – 6.00	1.25	2.25	12.00	2.25	8.00
4	8.00 – 10.00	2.25	4.00	24.00	4.00	12.00
5	Over 10.00	3.75	5.00	32.00	5.00	16.00

Table G-1: Marking Details



APPENDIX H: PIPING COLOUR IDENTIFICATION LEGEND

SERVICE	IDENTIFICATION LEGEND	COLOUR			
		DIRECTION ARROW	CODE	BACKGROUND	CODE
PROCESS LINE					
Gas	Gas	Black	00E53	OSHA Yellow	RAL 1003
Liquid	Liquid	Black	00E53	OSHA Yellow	RAL 1003
Process	Process	Black	00E53	OSHA Yellow	RAL 1003
DRAIN & RELIEF					
Drain, Hot Oil	Hot Oil Drain	Black	00E53	OSHA Yellow	RAL 1003
Drain, Pressurised	Pressure, Drain	Black	00E53	OSHA Yellow	RAL 1003
Drain, Hazard	Hazard, Drain	Black	00E53	OSHA Yellow	RAL 1003
Drain, Condensate	Cond. Drain	Black	00E53	OSHA Yellow	RAL 1003
Flare, High Pressure	HP Flare	Black	00E53	OSHA Yellow	RAL 1003
Flare, Low Pressure	LP Flare	Black	00E53	OSHA Yellow	RAL 1003
Vent	Vent Line	OSHA Blue	RAL 5005	White	00E55
Vent, Atmospheric	Atm Vent	OSHA Blue	RAL 5005	White	00E55
STEAM & CONDENSATE					
Condensate	Condensate	Black	00E53	OSHA Yellow	RAL 1003
Steam	Steam	Black	00E53	OSHA Yellow	RAL 1003
Boiler Feed Water	Boiler H ₂ O	Black	00E53	OSHA Yellow	RAL 1003
UTILITY WATER					
Cooling Water	Cooling H ₂ O	OSHA Green	RAL 6032	White	00E55
Firewater	Fire H ₂ O	OSHA Red	RAL 3001	White	00E55
Potable Water	Potable H ₂ O	OSHA Green	RAL 6032	White	00E55
Service Water	Service H ₂ O	OSHA Green	RAL 6032	White	00E55
Ballast Water	Service H ₂ O	OSHA Green	RAL 6032	White	00E55
Sea Water Washdown	Service H ₂ O	OSHA Green	RAL 6032	White	00E55
Chilled Water	Chilled H ₂ O	OSHA Green	RAL 6032	White	00E55
UTILITY AIR & GENERAL					
Air, Instrument	Instrument Air	OSHA Blue	RAL 5005	White	00E55
Air, Utility	Utility Air	OSHA Blue	RAL 5005	White	00E55
UTILITY GAS & FUEL					
Blanket Gas	Blanket Gas	Black	00E53	OSHA Yellow	RAL 1003
Diesel Fuel	Diesel Fuel	Black	00E53	OSHA Yellow	RAL 1003
Aviation Fuel	Aviation Fuel	Black	00E53	OSHA Yellow	RAL 1003
Fuel Gas	Fuel Gas	Black	00E53	OSHA Yellow	RAL 1003
Nitrogen	Nitrogen	OSHA Blue	RAL 5005	White	00E55
Gas, Instrument	Instrument Gas	Black	00E53	OSHA Yellow	RAL 1003
Gas, Utility	Utility Gas	Black	00E53	OSHA Yellow	RAL 1003
UTILITY OIL					
Lube Oil	Lube Oil	Black	00E53	OSHA Yellow	RAL 1003
Seal Oil	Seal Oil	Black	00E53	OSHA Yellow	RAL 1003
Hot Oil	Hot Oil	Black	00E53	OSHA Yellow	RAL 1003
Hydraulic	Hydraulic	Black	00E53	OSHA Yellow	RAL 1003
CHEMICALS					

SERVICE	IDENTIFICATION LEGEND	COLOUR			
		DIRECTION ARROW	CODE	BACKGROUND	CODE
Chemical	Chemical	Black	00E53	OSHA Yellow	RAL 1003
Glycol	Glycol	Black	00E53	OSHA Yellow	RAL 1003
Caustic	Caustic	Black	00E53	OSHA Yellow	RAL 1003
Chlorine	Chlorine	Black	00E53	OSHA Yellow	RAL 1003
Chemical	Chemical	Black	00E53	OSHA Yellow	RAL 1003
GENERAL					
Treated Water	Treated H ₂ O	OSHA Green	RAL 6032	White	00E55
Black Water	Black H ₂ O	OSHA Green	RAL 6032	White	00E55
Grey Water	Grey H ₂ O	OSHA Green	RAL 6032	White	00E55
Hot Water	Hot H ₂ O	Black	00E53	OSHA Yellow	1003

Table H-1: Colour coding scheme for piping

APPENDIX I: COLOUR SCHEME FOR ONSHORE/OFFSHORE INSTALLATION AND EQUIPMENT

I-1 STRUCTURE COLOUR SCHEME

NO	COMPONENTS	COLOUR	CODE			
			BS4800	RAL	BS381C	RGB
1.1	Splash Zone/Spider Deck Offshore structural members steel below castellation point (shim connection splash zone substructures), spider deck and boat landing	Yellow and Black Stripe	10E53 00E53	-	-	233;193;0
1.2	Cellar Deck to Main Deck including Bridge Structure Structural member, from cellar deck up to the main deck, castellation point outwards, beam, girder, pipe & cable support, conduits barrel	Yellow	10E53	-	-	233;193;0
1.3	Deck Plate	Yellow	10E53	-	-	233;193;0
1.4	Chequer Plate	Yellow	10E53	-	-	233;193;0
1.5	Footway, walkway, stairway supports and monkey ladder	Yellow	10E53	-	-	233;193;0
1.6	Grating panel (maintenance only)	Yellow	10E53	-	-	233;193;0
1.7	Handrail and kick plate	OSHA Orange	08E55	2009	-	222;83;7
1.8	Module (including Living Quarter) Interior Wall and Interior Ceiling External part of partition wall at module Deck Top of Living Quarter Production Shed & Equipment Store	White Yellow Yellow White	00E55 10E53 10E53 00E55	- - - -	- - - -	241;242;234 233;193;0 241;242;234 233;193;0
1.9	Helideck Structure Structure and underside helideck Netting frame	Yellow White	10E53 00E55	- -	309 -	233;193;0 241;242;234
1.10	Helideck landing area	Dark Green Red White				
1.11	Brucker Davit Structure for Lifeboat The colour may be selected from the options listed according to specific operator practise.	OSHA Yellow OSHA Orange OSHA Red OSHA Green OSHA Blue	10E53- 08E55- 04E53 14E53 20E53	1003 2009 3001 6032 5005	- - - - -	249;168;38 222;83;7 155;36;35 35;127;82 0;83;135
1.12	Conductor pipe (splash zone and above)	Yellow	10E53	-	-	233;193;0
1.13	Riser (splash zone until launcher/receiver)	Yellow	10E53	-	-	233;193;0
1.14	Structure, pipe rack along with its support legs (for onshore application)	White	00E55	-	-	241;242;234
1.15	Instrument Control Panel, Instrument & Lighting Stand	White	00E55	-	-	241;242;234

NO	COMPONENTS	COLOUR	CODE			
			BS4800	RAL	BS381C	RGB
1.16	Offshore flare boom inclusive of piping and associated structure from bottom of the structure to the top of flare boom Note: High temperature coating system for application at flare boom.	Aluminium	-	9006	-	161;161;160
1.17	Onshore flare tower	OSHA Red White (in seven alternate bands)	04E53 00E55	3001 -	- -	155;36;35 241;242;234
1.18	Communication tower	OSHA Red White (in seven alternate bands)	04E53 00E55	3001 -	- -	155;36;35 241;242;234
1.19	Riser Guard	OSHA Red White Stripe	04E53 00E55			

Table I-1: Structure colour scheme

I-2 PIPING COLOUR SCHEME

NO	COMPONENTS	COLOUR	CODE		
			BS4800	RAL	RGB
2.1	Pipework Note: This excludes firewater line and foam line.	White	00E55	-	241;242;234
2.2	Pipework for firewater service	OSHA Red	-	3001	155;36;35
2.3	Process/Utility piping operating above 110°C Note: This is also applicable for piping along flare boom.	Aluminium	-	9006	161;161;160
2.4	Pipework for foam system	OSHA Yellow	-	1003	249;168;38

Table I-2: Piping colour scheme

I-3 VALVE COLOUR SCHEME

NO	COMPONENTS	COLOUR	CODE		
			BS4800	RAL	RGB
3.1	Valve body Note: This is applicable for all valves except valves for fire water system	White	00E55	-	241;242;234
3.2	Valve for fire water system	OSHA Red	-	3001	155;36;35
3.3	Pressure relief valve and other operated ON/OFF actuated valve or selector valve	As per operation practice	-	-	
3.4	Actuated Control Valve Body SDV / ESD Valve Actuators BDV Actuators MOV Actuators Control Valve actuators (Fail Close) Control Valve actuators (Fail Open)	White OSHA Red OSHA Green Grey OSHA Red OSHA Green	00E55 - - 00A05 - - -	- 3001 6032 - 3001 6032	241;242;234 155;36;35 35;127;82 177;176;174 155;36;35 35;127;82
3.5	Hand wheel/handle for valve	Black	00E53	-	47;47;48

Table I-3: Valve colour scheme

I-4 EQUIPMENT COLOUR SCHEME

NO	COMPONENTS	COLOUR	CODE		
			BS4800	RAL	RGB
4.1	Pressure vessels, columns, heat exchangers	White	00E55	-	241;242;234
4.2	Wellheads	Irish Green	14E53	-	43;147;104
4.3	Storage tank	White	00E55	-	241;242;234
4.4	Inside drip pan including pipeworks	Black	00E53	-	47;47;48
4.5	Jib crane and gantry crane booms and monorail track	Alternate	00E53	-	47;47;48
		Black & Yellow	10E53	-	233;193;0
4.6	Pedestal crane - inclusive of crane structures (pedestal adaptor, machinery deck, powerpack and other steel structures), crane boom, operator cabin and tank	Yellow	10E53	-	233;193;0
4.7	Pumps, motors, generators and other rotating equipment Note : Excluding firewater pump	Irish Green	14E53	-	43;147;104
4.8	Compressor casing Note: Other component's colour scheme shall be as per OEM specification.	Irish Green	14E53	-	43;147;104
4.9	Equipment package skid	Yellow	10E53	-	233;193;0
	Structure and Piping	White	00E55	-	241;242;234
	Tank	White	00E55	-	241;242;234
	Pump & motor body	Irish Green	14E53	-	43;147;104

NO	COMPONENTS	COLOUR	CODE		
			BS4800	RAL	RGB
4.10	Launcher & receiver barrel including end closure	White	00E55	-	241;242;234
4.11	Chemical injection skid Structure and Piping Tank Pump & motor body	Yellow White White Irish Green	10E53 00E55 00E55 14E53	- - - -	233;193;0 241;242;234 241;242;234 43;147;104
4.12	Corrosion coupon/probe cover	OSHA Blue or as per manufacturer specification	-	5005	0;83;135
4.13	Nitrogen package skid Structure Piping Nitrogen bottle	Yellow White As per manufacturer specification	10E53 00E55 -	- - -	233;193;0 241;242;234
4.14	Foam System	OSHA Yellow	-	1003	249;168;38
4.15	Pig signaller	As per manufacturer specification	-	-	

Table I-4: Equipment colour scheme

15 SAFETY COLOUR SCHEME

NO	COMPONENTS	COLOUR	CODE		
			BS4800	RAL	RGB
5.1	Escape route on deck and grating	OSHA Yellow at pathway with OSHA Yellow and Black (in alternate bands) at border and Black arrow showing the direction	- 00E53	1003 -	249;168;38 47;47;48
5.2	Dangerous obstructions (inclusive piping & structure)	OSHA Yellow and Black (in alternate bands)	- 00E53	1003 -	249;168;38 47;47;48
5.3	Dangerous or exposed parts of machinery	OSHA Orange	-	2009	222;83;7
5.4	Fire Equipment and services	OSHA Red	-	3001	155;36;35
5.5	Firewater line – including sprinkler system	OSHA Red	-	3001	155;36;35
5.6	Foam System	OSHA Yellow	-	1003	249;168;38
5.7	First Aid Equipment	OSHA Green	-	6032	35;127;82

Table I-5: Safety colour scheme

I6 MISCELLANEOUS

NO	COMPONENTS	COLOUR	CODE		
			BS4800	RAL	RGB
6.1	Platform Nameplate Background Lettering	Yellow Black	10E53 00E53	- -	233;193,0 47;47;48
6.2	Fire proofing – inclusive of Passive Fire Protection (PFP)	As per equipment/ structure colour	-	-	

Table I-6: Miscellaneous colour scheme

APPENDIX J: ESCAPE ROUTE

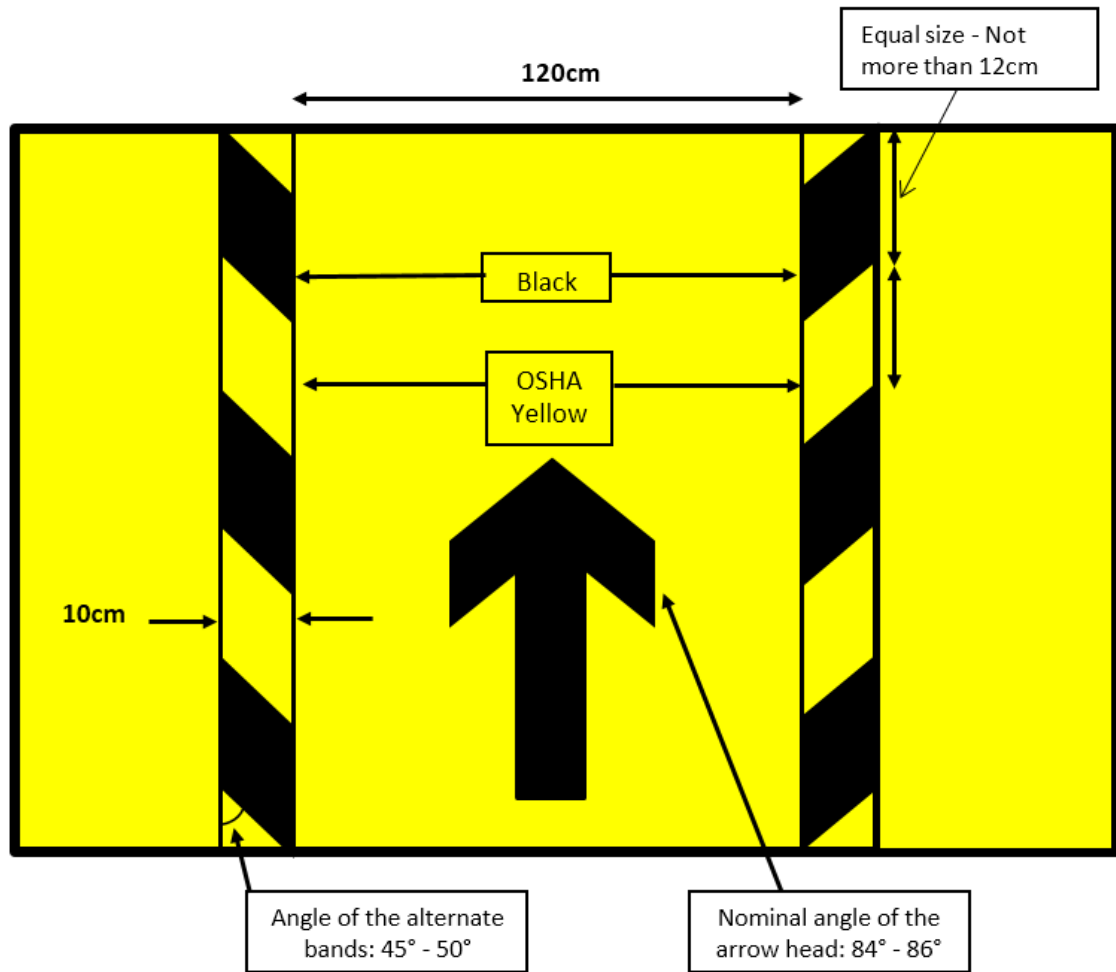


Figure J-1: Escape route marking guide

APPENDIX K: INSPECTION AND TESTING REQUIREMENTS

Test Type	Method	Reference Standard	Frequency	Acceptance Criteria	Consequence
Environmental Condition	Ambient and steel temperature Relative humidity Dew point Wind speed	ASTM E 337	Before start of each work activity + Every 2 Hours during surface preparation and coating operations	In accordance with specified requirements and Coating Manufacturer's TDS	No blasting or coating application or rejection of prepared or coated surface
Abrasive Materials	Particle Size and Sharpness check by visual at all work sites	SSPC AB 1 SSPC AB 2 SSPC AB 3 ISO 11126 ISO 11127-6	Every new batch and spot checks Certificate checks	In accordance with specified requirements, as per relevant sections of ISO 11126 and ISO 11127-6 Test plates shall be abrasive blasted for use as reference of visual appearance / anchor profile	No blasting
Compressed Air Cleanliness	Standard Test Method for Indicating Oil or Water in Compressed Air	ASTM D4285	Before start of each shift or change in air system	No visible contamination	Service, clean and replace
Visual Examination of Pre-Cleaned Metal	Visual Inspection for sharp edges, weld splatter, Slivers, lamination, structurally deleterious defects, rust grade etc.	N/A	100% of all surfaces	No defects	No blasting or coating application until defect is repaired
Surface Cleanliness (visual)	Visual Assessment of Surface Cleanliness	SSPC VIS 1 or ISO 8501 ISO 8502-3	100% visual of all surfaces Spot checks	In accordance with specified requirements	Re-blasting Re-cleaning and retesting until acceptable

Test Type	Method	Reference Standard	Frequency	Acceptance Criteria	Consequence
Soluble Salts (Not required if Final surface preparation by UHP Water Jetting)	Extraction: ISO 8502-6 (Bresle) Assessment: ISO 8502-9 (Conductometric) Extraction: SSPC Guide 15 Section 4.6 (Elcometer130 SC400) Assessment: SSPC Guide 15 Section 5.3 (Conductometric)	ISO 8502-6 ISO 8502-9 SSPC Guide 15 (Section 4.6 & 5.3)	Immersion Service: 6 samples/2000 m2 (20,000 ft2) but not less than 2 samples/ Atmospheric Surfaces: 2 samples/2000 m2 (20,000 ft2)but not less than 2 samples/ pieces of equipment or structure	Average conductivity corresponding to 20 mg/m2 and maximum conductivity .. Average conductivity corresponding to 30 mg/m2 and maximum conductivity corresponding to 40 mg/m2 water soluble salt(s)	Steam or clean water washing and retesting until entire 2000 m2 (20,00 ft2) test area is
Roughness	Comparator, Replica tape or Stylus instrument	ISO 8503	Each component or once per 10m ² .	As specified	Re-blasting
Visual Examination of Coating	Visual to determine: Curing, contamination, solvent retention, pinholes/popping, sagging, surface defects	N/A	100% of surface after each coat	None observed	Repair of defects.
Dry Film Thickness	Measurement by Dry Film Thickness Gauge Calibration on smooth surface	SSPC PA2 ISO 19840	As per SSPC PA2 requirements	The average DFT of each measurement point shall be 100% specified DFT, No single measurement shall be less than 20% below the specified DFT	Repair, additional coats, or recoating as appropriate

Test Type	Method	Reference Standard	Frequency	Acceptance Criteria	Consequence
Holiday Test (Supplementary Test) Holiday Detection only for Internal Lining or Immersion/ Buried Surfaces	NACE RP 0188 Voltage, ref. TABLE 1	NACE RP0188 ASTM D5162	As per system specification / 100% Surface of each coat	No holidays	Repair and retesting
Adhesion (Supplementary Test)	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers	ASTM D4541 ISO 4624	Spot check – not to be used for coatings to be placed in immersion	For coating types other than PFP minimum 5MPa (72PSI)	Repair and retesting

Table K-1: Inspection and Testing Summary

APPENDIX L: ITEMS TO BE EXCLUDED FROM PTS 15.20.03

Category	Type	PTS No. and Description	Typical Use
Coating	Bituminous Enamel	31.40.30.33: Bituminous Enamel Coating of Steel Linepipescope	• Buried Pipelines External
	Concrete	11.32.09: Concrete Coating of Linepipe	• Subsea Pipeline External
	Ceramic	New PTS	• Heater Tubes External
	Elastomer	31.40.30.36: Elastomer Coatings and Monel Sheathing for Offshore Riser Protection	• Offshore Riser External
	External Polyethylene And Polypropylene	11.32.03: External Polyethylene And Polypropylene Coating Of Linepipe	• Buried Pipelines External
	Fusion Bonded Epoxy (FBE)	20.214: Pipeline and Riser Engineering	• Buried Pipelines External
	Thermal Spray Application (TSA)	15.20.05: Thermal Spray Coatings - Aluminium and 85/15 Zinc/Aluminium Alloy	• Offshore Facilities • Corrosion Under Insulation (CUI) Mitigation • High temperature swing operations e.g. Regeneration system
	Subsea	To refer to Norsork Standards or other industry recognized standards	• Subsea equipment, structure, piping etc.
Lining	Cement	<u>30.48.30.31</u> : Cement Lining of Pipes	• Pipeline Internal • Seawater Piping Internal
	Glass Flake	30.48.70.30: Glass Lined Steel Equipment and Piping	• Vessel and Tank Internal
	Rubber	30.48.60.10: Rubber-Lined Process Equipment	• Sea Cooling Water Exchanger Internal • Vessel and Piping Internal
	Thermoplastic	11.32.06: Thermoplastic Lined Pipelines	• Pipeline Internal
Others	Surface treatment + PTFE	New PTS	• Bolts and nuts

Table L-1: List of excluded item

Other Exceptions:

- GRP Gratings
- Equipment or Instrumentation designated to be hand or machine tool cleaned
- All Electrical Wiring, Cables, and cable Trays
- Safety Equipment, Sensors and Alarms
- All piping/equipment operating above 55°C (NOTE: This refers to surface temp during coating operations, not service temperatures)
- Shock Cell Pads and Wear pads on boat landing
- Fire Proofed Surfaces and Cryogenic Lines (external Surfaces)
- Greased nipples and fittings and lubricated surfaces
- Machined and close working tolerance surfaces
- Gasket contact surfaces and exposed seals, bearings and Glands.
- Threaded Connections shall not be coated unless otherwise specified.
- Friction grip surfaces
- Equipment identification plates and information / warning signs.
- Valve stems, stem threads, movable linkages, and pump shafts.
- Glass components, Sensitive parts of Instrumentations and Gauges. (Instrument tubing)
- Area of component to be site welded or welds subsequently to be modified especially during Shutdown.
- Bolt and Nuts which are subjected to removal

APPENDIX M: REGULATIONS ON ABRASIVES, COATING PRODUCTS, WASTE PRODUCTION, PRODUCT STORAGE AND LEACHING OF COATINGS

M1 ABRASIVE BLAST CLEANING

M1.1 Significant quantities of dust from the abrasive and the surface debris are made airborne and can contribute to air pollution. This dust is recognised as a fugitive emission that is often regulated. Control of mineral dust exposure shall be in compliance with the Environmental Quality (Clean Air) Regulations 1989 and Factories and Machinery (Mineral Dust) Regulations 1989. The PEL averaged over an 8-hour period without respirators shall be:

- i. Less than 10mg/m³ concentration of free silica in total dust
- ii. Less than 0.05mg/m³ concentration of respirable cristobalite in crystalline silica
- iii. Less than 0.1mg/m³ concentration of respirable quartz in crystalline silica
- iv. Less than 0.05mg/m³ concentration of respirable tridymite in crystalline silica

M1.2 If respirators are used by employee and all control measures related to this hazard has been employed, the exposure level shall be determined by the protection factor provided by the respirator

M2 COATING APPLICATION

M2.1 In the process of spraying, a substantial portion of the liquid coating does not coat the substrate but is lost due to overspray. In addition, most coatings have appreciable quantities of volatile organic compounds (VOC) that can contribute to smog formation.

M3 WASTE PRODUCTION

M3.1 Both coating removal and coating application generate waste products, which must be properly disposed of. In many instances, the waste may be classified as hazardous by the Environmental Quality Act (EQA) 1974 because of heavy metal (e.g. lead) content of the residue, or the solvents of unused coating or thinner.

M3.2 The control of Scheduled Wastes shall be in compliance with the Environmental Quality Act 1974 (Act 127) Part IV A Section 34B. Scheduled wastes as identified in Environmental Quality (Schedule Wastes) Regulation, 1989 First Schedule (Regulation 2) Part I "Schedule Wastes from Non Specific Sources" and Part II "Schedule Wastes from Specific Sources" shall collected and disposed of at Prescribed Premises.

M3.3 These Prescribed Premises shall be in compliance with the Environmental Quality (Prescribed Premises) (Schedule Wastes Treatment and Disposal Facilities) Order, 1989 and Environmental Quality (Prescribed Premises) (Scheduled Wastes Treatment and Disposal Facilities) Regulations, 1989.

M4 PRODUCT STORAGE

M4.1 The storage of certain products is regulated by EQA 1974 because of the potential ecological damage that could result from a spill or leak from storage vessels.

M5 LEACHING OF COATINGS

- M5.1 Under certain circumstances, toxic or otherwise undesirable components of applied coating films may leach into the environment.
- M5.2 The above activities collectively can affect almost all the major environmental receptors i.e. air, soil, groundwater, surface water, potable water.
- M5.3 Contractor Environmental Programme shall comply with the Malaysian Environmental Quality Act (EQA), 1974 relating to the prevention, abatement, and control of pollution and enhancement of the environment.
- M5.4 Contractors hired to remove hazardous coating shall be qualified in accordance with the procedures described in SSPC-QP 2(I). The qualification process shall evaluate four (4) functions:
 - i. Management of Hazardous Coating Removal
 - ii. Technical Capabilities
 - iii. Qualification of Personnel
 - iv. Safety and Health