

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

PROCEDURAL SPECIFICATION

PROTECTIVE COATINGS AND LINING

PTS 30.48.00.31-P

FEBRUARY 2008





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Subject: MAINTENANCE MANAGEMENT

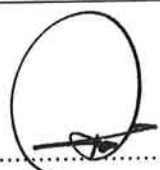
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Please be informed that the referred PTS has been revised.

The whole content of PTS 30.48.00.31-P (February 1993) shall be supplemented by **(Revision 1 – February 2008)** amendments specified herein onwards.

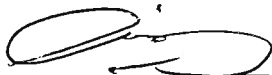
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INTRODUCTION

The custodian of this PTS has assessed/reviewed/evaluated the stated PTS and offered the following exceptions/amendments. This PTS also includes PETRONAS Lessons Learnt and PETRONAS Best Practice for the subject matter as stated above.

All updates to the PTS has been incorporated into the main body of the PTS and highlighted as *italic* font.


 Ir Che Wan Ibrahim Che Wan Sudin
 Head of Material, Corrosion and Inspection
 Date: 21/3/08

PREFACE

PETRONAS Technical Standards (PTS) publications reflect the views, at the time of publication, of PETRONAS OPU/Divisions.

They are based on the experience acquired during the involvement with the design, construction, operation and maintenance of processing units and facilities. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good technical practice to be applied by PETRONAS' OPU/Divisions in oil and gas production facilities, refineries, gas processing plants, chemical plants, marketing facilities or any other such facility, and thereby to achieve maximum technical and economic benefit from standardisation.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where PTS may not cover every requirement or diversity of condition at each locality. The system of PTS is expected to be sufficiently flexible to allow individual operating units to adapt the information set forth in PTS to their own environment and requirements.

When Contractors or Manufacturers/Suppliers use PTS they shall be solely responsible for the quality of work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will expect them to follow those design and engineering practices which will achieve the same level of integrity as reflected in the PTS. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal or its technical advisor.

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PURPOSE

The Purpose of this industrial standard is to standardise and to improve Protective Coating Specification to optimise cost of painting without compromising Quality and Coating Performance in accordance with the guideline stipulated in Appendix 1.

This standard is also intended for use by Engineers and Specifiers to select Painting Systems and Coating Systems to be used and applied on metallic substrates requiring protection from corrosion in the marine environment.

Decision to implement all works described herein shall be justified in view of its potential value creations and annual cost savings and to fulfil the philosophy stated herein :

- ◇ To maintain the integrity of oil and gas production facilities by minimising materials degradation caused by corrosion.
- ◇ To enhance in-service performance of coating systems through proper paint materials selection, quality control during application, continuous monitoring and proper maintenance.
- ◇ Continuous improvement towards cost effective painting practices by acquiring, testing and utilising new coating systems and technology through :
 - ✦ Collective efforts and systematic feedback by all Users,
 - ✦ Centralised Committee, **the PETRONAS Protective Coatings and Lining Technical Committee (PCLTC)**
 - ✦ **Close co-operation and alliancing between PSCs, Partners, paint manufacturers, independent bodies, professional bodies and research institutes e.g. PETRONAS Research Sdn Bhd (PRSB), DOE, SIRIM, CIDB and IMM.**
- ◇ To create high level of corporate awareness in PETRONAS OPU/Divisions, all PSCs and other service companies on the importance of protective coating in controlling corrosion.
- ◇ To promote Health, Safety and Environmental (HSE) awareness in the Malaysian Protective Coating industry.

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SCOPE

The scope of this specification is to provide minimum requirements for both external and internal coating of both onshore and offshore facilities in the oil and gas industry. It shall also include initial and maintenance painting.

The specification is not applicable to buried and submerged structures below the splash zone.

Specialised equipment supplied by vendors such as valves, pumps, compressors, etc. will be coated in compliance with the User's respective functional specification; as such they are not covered under this publication.

This revision has included coating systems recommended for the protection of bolts and nuts. Refer to Appendix 12.

DEFINITIONS

Owner	The Production Sharing Contractors (PSC) who operates the facilities.
Contractor	A firm that performs paint removal, surface preparation, and coatings application in the industrial market.
Painting System	A term intended to include, with equal emphasis, not only the well accepted components of a system such as surface preparation and paint materials, but also the application, inspection, and safety functions.
Coating System	A term which refers to the applied and cured multilayer film or to the components of a system based on non-paint type coating.
Paint	In the general sense, includes primers, enamels, varnishes, emulsions, catalysed coatings, bituminous coatings, and other organic coatings. Inorganic coatings which are applied in the same manner as paints are included in this definition.
Work	A term which refers to all works associated with the selection of the painting and coating systems, surface preparation, paint application, and inspection.
"Ideal/Optimum" Service Life	The time until initial breakdown (3 - 5 %) of the top-coats occurs, before 1% rusting begins, and ASTM D 610, Rust Grade 6 is present, when first maintenance painting takes place.
"Practical" Service Life	The time until 10% through thickness coating breakdown occurs, active rusting of the substrate occurs, and ASTM D 610, Rust Grade 4 is present.
Initial painting facilities	Painting of new construction projects or complete recoating of existing during major maintenance.
Maintenance painting	Periodic painting (repair/touch up of corroded areas or deteriorated paintwork) after initial painting.
Custodian	Owner of this specification i.e. PETRONAS, PETRONAS, Research and Technology Division, Group Technology Solutions (GTS)
Protective Coating Committee	Appointed members or their alternate of the PETRONAS Protective Coatings and Lining Technical Committee (PCLTC)
Originator	The Individual who are authorised users of this specification.
PSC	Production Sharing Contractors - companies having agreement with PETRONAS to operate certain concession areas in upstream activities in Malaysian water.

4 SURFACE PREPARATION

4.1 GENERAL

For optimum paint coating performance, surfaces to be painted or coated shall be completely dry and free from burrs, weld spatter, flux, rust, loose scale, dirt, grease, oil and other foreign matter before any paint is applied.

If the surface has been exposed to a polluted, e.g. salt-laden atmosphere, it shall be tested for presence of contaminants in accordance with procedures described in ISO 8502-1 and the contaminants removed in accordance with procedures described in NACE Publication 6G186 prior to blasting or power tool cleaning.

After preparation of the substrate surface, any grit, dust etc. shall be removed and a layer of primer applied before any corrosion or recontamination occurs, normally within 4 hours after blasting.

Surface preparation shall be carried out by dry blast-cleaning wherever possible. The surface preparation grades shall be as specified for the various painting and coating systems described in section 6.2 and 6.3. The nearest equivalents of the main surface preparation specifications are given below :

NEAREST EQUIVALENTS OF THE MAIN SURFACE PREPARATION SPECIFICATIONS			
ABRASIVE BLAST CLEANING	SSPC	ISO 8501-1	NACE
EXTREMELY THOROUGH. WHITE METAL BLAST.	SP 5	Sa 3	No 1
VERY THOROUGH. NEAR WHITE METAL BLAST.	SP 10	Sa 2.5	No 2
THOROUGH. COMMERCIAL BLAST.	SP 6	Sa 2	No 3
LIGHT. BRUSH-OFF BLAST.	SP 7	Sa 1	No 4
TOOL CLEANING	SSPC	ISO 8501-1	NACE
EXTREMELY THOROUGH. POWER TOOL CLEANING.	SP 11	-	-
VERY THOROUGH. POWER TOOL CLEANING.	SP 3	St 3	-
THOROUGH. HAND TOOL CLEANING.	SP 2	St 2	-
SOLVENT CLEANING	SSPC	ISO	NACE
SOLVENT CLEANING	SP 1	-	-

Surface preparation shall be subjected to inspection before the prime coat is applied to ensure all traces of dust and foreign matter have been removed by brushing, blowing with dry clean compressed air, or vacuum cleaning.

4.2 PRE-CLEANING OF SURFACES AND SOLVENT CLEANING

This cleaning procedure is mandatory before further cleaning or surface preparation. Prior to the actual cleaning operation, surface contaminants such as oil, grease, hydrocarbon, etc. shall be removed preferably by degreasing with suitable degreaser or solvent cleaning according to SSPC-SP1. The degreased surface shall be further washed with fresh water to remove all traces of the degreaser chemicals. The surface shall be allowed to dry thoroughly before proceeding with any further coating work. This procedure also applies to all metal surfaces to be coated that do not require blast cleaning or power tool cleaning.

Excessive rust scale shall be removed by impact cleaning tools or high pressure water jetting.

Before abrasive blast cleaning, all equipment which could be damaged by blast,

dust or

particulate matter shall be suitably protected by masking, wrapping, taping, or other means to prevent damage. Where required, the degree of contamination shall be assessed in accordance with procedures described in ISO 8502-3. These equipment shall include, but not necessarily be limited to, the following :

- ◇ Bearings
- ◇ Control panels
- ◇ Control valves
- ◇ Conduit
- ◇ Instrument dials
- ◇ Expansion joint bellows
- ◇ Machined surfaces
- ◇ Shafts
- ◇ Push buttons
- ◇ Tags
- ◇ Screws
- ◇ Exposed moving parts

All edges shall be ground to a minimum radius of 2 mm; flame cut areas shall be ground flush. If this is not the case, Owners shall be informed, and corrective action shall be taken prior to final surface preparation.

Offshore maintenance painting projects shall always start with a high pressure steam/detergent cleaning to remove dirt and salt deposits. In addition, after a long interval prior to the application of subsequent layers of a coating system, or after a storm the surface shall be steam cleaned before the application of the next layer.

4.3 SURFACE PREPARATION BY BLAST CLEANING

4.3.1 General

Blast cleaning shall be carried out through ISO 8504-2:1992 to the required visual standard in accordance with ISO 8501-1:1988 or equivalents. The minimum requirement for successful coating application shall be Sa 2.5 at the time of coating.

The blasting of stainless steel shall be carried out by sweep blasting using a fine abrasive not containing iron (e.g. garnet, aluminium oxide), glass pearls or stainless steel shot. To reduce the risk of unacceptably damaging the substrate while sweep blasting stainless steel or hot dip galvanised surfaces, it is recommended that a reduced nozzle pressure be used in combination with a small size abrasive.

4.3.2 Blast Cleaning equipment

The compressed air supply used for blast cleaning shall be free from water and oil. A test in accordance with ASTM D 4285 shall be conducted to determine the presence of oil or water in compressed air used.

Adequate separators and traps shall be provided, installed in the coolest part of the system. They shall be emptied regularly to prevent carry over of water and oil. Accumulation of oil and moisture shall be removed from the air receiver by regular purging.

Air compressors shall not be allowed to deliver air at a temperature above 110 °C.

Abrasive blast cleaning equipment shall be an intrinsically safe construction and equipped with a remote shut-off valve triggered by the release of a dead man's handle at the blasting nozzle.

Where air-operated equipment is used, the operator's hood or head gear shall be ventilated by clean, cool air served through a regulator filter, to prevent blast cleaning residues from being inhaled.

4.3.3 Blasting Abrasives

Blasting abrasives for use in blast cleaning carbon steels and low alloy steels are specified in ISO 8504-2. Recommended blasting abrasives are as follows, but not limited to :

- ◇ Chilled Iron Grit or Shot
- ◇ Steel and Malleable Iron Grit or Shot
- ◇ Natural Mineral Abrasives
- ◇ non-metallic abrasives

All blasting abrasives shall meet the requirements of SSPC-AB 1 : Abrasive Specification No. 1; Mineral and Slag Abrasives. Any blasting abrasives qualification shall be performed in accordance with the procedure described in QP-AB 1 : Procedure for Qualification and Conformance Testing of Blasting Abrasives.

Where abrasives which are classified as a Scheduled Waste are used, the waste shall be collected and disposed of at prescribed premises as per the requirement of the Environmental Quality Act (EQA) 1974 .

Sand or other materials producing silica dust shall not be used.

All metallic blast-cleaning abrasives shall meet the requirements of ISO 11124 and tested in accordance with test methods specified in ISO 11125 (Parts 1-7)

All non-metallic blast-cleaning abrasives shall meet the requirements of ISO 11126 and tested in accordance with test methods specified in ISO 11127 (Parts 1-7)

Any blast-cleaning abrasives qualification shall be performed in accordance with the procedure described in QP-AB 1 : Procedure for Qualification and Conformance Testing of Blast-Cleaning Abrasives (to be amended to reflect ISO 11124, 11125, 11126 and 11127 requirements)

The blast profile and angular anchor pattern shall be that recommended by the paint manufacturer to suit the minimum requirement of their respective primers; and the minimum peak-to-valley height shall be 25 microns. Roughness or anchor pattern measurement shall be carried out by the painting contractor using instruments approved by Owners and in accordance with the procedures described in ASTM D 4417. Where anchor patterns are not specified in the paint manufacturer's technical data, table below shall be used and NACE RP0181 shall be referred as a guide for determining the anchor pattern.

Relationship Between Coating Thickness and Anchor Pattern	
Dry Film Thickness	Anchor Pattern
125 - 200 m (5 - 8 mils)	25 - 50 m (1 - 2 mils)
200 - 500 m (9 - 20 mils)	50 - 75 m (2 - 3 mils)
500 m or more (over 20 mils)	5 m (3 - 5 mils)

4.3.4 Techniques and Restrictions

As a guide, blast cleaning shall not be carried out when the temperature of the surfaces to be blasted is less than 3°C above dew point and when the relative humidity of the air is greater than 85%. For dew point determination refer to the procedure described in ASTM E 337.

In enclosed areas such as in Tanks and Vessels; where some adverse conditions (i.e. environmental conditions outside the range of the specifications or short turnaround time allotted) may prevail, dehumidification is recommended to prevent flash rusting. In the event that dehumidification is employed the Relative Humidity (RH) within such an enclosure shall be maintained at a maximum of 50% RH except for Inorganic Zinc Silicate. NACE Publication 6A192 may be referred to determine the types of dehumidification equipment suitable for the work.

Abrasive blasting shall not be done in open areas close to painting operations or wet coated surfaces to prevent dust and grit contamination. Normally grit blasting shall be permitted only during daylight hours except that rough abrasive blasting will be allowed during the night provided that the surface is subsequently blasted to the specified standard under good light conditions. The illumination of the surface during final blasting shall be at least 500 Lux and all environmental restrictions shall be observed.

Maximum speed and most effective cleaning are obtained by systematic even blasting. Work should be blocked out in 30 cm squares and each square blasted evenly until complete.

All welded areas and appurtenances shall be given special attention for removal of welding flux in crevices. Welding **spatter**, slivers, laminations and underlying mill scale removed during fabrication and exposed before and during blast cleaning operations shall be removed by the best mechanical means and the edges smoothed or rendered flush.

Where rectification is necessary on abrasive blast cleaned surfaces, the dressed areas shall be reblasted to remove all rust and grits, and to provide an adequate anchor pattern.

Blasting shall continue a minimum of 25 mm into any adjacent coated areas, and the edges shall be feathered.

After dry blast cleaning, no acid washes, cleaning solutions, solvents or other chemical treatments shall be used on metal surfaces. This restriction includes inhibitive washes to prevent rusting.

Any blast cleaned steelworks on which rust develops shall be reblasted prior to being painted.

4.4 SURFACE PREPARATION BY HAND AND POWER TOOL CLEANING

The most technically effective surface preparation method is blast-cleaning mentioned in section 4.3. Manual preparation shall only be used when blast-cleaning is either not feasible or not strictly required, e.g. galvanised steel, stainless steel.

Manual cleaning shall be performed using hand wire brushes or mechanically operated tools (grinders, chippers or wire brushes) in accordance with ISO 8504-3. The surface shall be left roughly abraded to meet the requirement of SSPC-SP11 and a burnished surface shall be avoided.

Where welds occur within these areas or when these areas cannot accommodate a power disc, power impact tools shall be applied (vibratory and rotary hammers, needle guns, chisels) followed by brush cleaning.

If the surface being prepared lies adjacent to a coated surface which is not to be refurbished, the power tool cleaning shall overlap the coated surface by at least 25 mm. The minimum requirement for successful coating application is St 3 at the time of coating.

Care shall be taken to ensure that the substrate surface does not become polished during power tool cleaning.

4.5 SURFACE PREPARATION AND CLEANING BY WATER JETTING

Where dry blast cleaning is not feasible or desirable because the resultant flying abrasive particles and drifting dust may damage highly sensitive rotary equipment and fillers, cause contamination of nearby mechanical equipment and structures, cause contamination of the environment, or explosion risk; an alternative method NACE No. 5/SSPC SP 12 may be considered for removing existing coatings and for surface cleaning.

Water jetting is effective in removing :

- ✦ deleterious amounts of water-soluble surface contaminants that may not otherwise be removed by dry abrasive blasting alone, specifically in the bottom of pits and craters of severely corroded metallic substrates;
- ✦ rust;
- ✦ shot-creting spatter;
- ✦ existing coatings and linings.

Because water jetting does not provide the primary anchor pattern known to the coatings industry, this specification recommends its use primarily for recoating projects where there is an adequate pre-existing profile.

The cleaned surfaces shall be dry before any paint is applied. Consultation with paint manufacturer is required for the selection of a suitable primer.

5 PAINT APPLICATION

5.1 Pre-Application Procedures

5.1.1 Materials Handling and Use

Storing, thinning, mixing and handling of paint materials shall be in accordance with the Manufacturer's recommendation. All paint materials and solvents shall be stored in the closed original container bearing the manufacturer's label until required for use. Each container must have full identification information including Manufacturer's name, product identification, batch number, expiry date and colour.

Hazardous chemicals shall be classified, packaged and labelled appropriately in compliance with the Occupational Safety and Health (Classification, Packaging and Labelling of Hazardous Chemicals) Regulations 1997 **and shall be disposed off as per OSHA 1994 requirement Hazardous chemical shall be classified, packaged and labelled appropriately in compliance with Occupational Safety and Health (Classification, Packaging and Labelling Hazardous Chemicals) Regulations 1997 and shall be disposed off as per OSHA 1994 requirement.**

All aspects of safety relating to the use of paints and associated thinners shall comply with the Manufacturer's requirement.

The Manufacturer's pot-life requirements shall be followed. Mixing of different brands or generic types of paint material is not permitted.

Surface shall be painted with Coating system specified in the Painting and Coating System Schedules in section 6.2 and 6.3 and using paint material in accordance with application data.

Paint shall be applied to dry, clean, prepared surface under conditions recommended in the manufacturer's product data.

5.1.2 Mixing and Thinning

All coating material shall be mixed by solvent proof mechanical stirrer for a sufficient time in order for proper mixing of one or two packs paint and bring the material to a uniform consistency. Sticks shall not be used.

Continuous agitation type spray pots shall be used when applying, heavily metal-pigmented paint such as zinc or aluminium loaded paint.

Thinner shall not be added to primer or paints unless necessary for proper application according to the Manufacturer's recommendation. The type of thinner used must comply with the manufacturer's recommendation.

5.1.3 Surface Treatments

Hydrostatic or other testing of welds shall be completed prior to painting weld lanes.

Ends of pipe and related components, tank plate, structural steel, and like areas of other items that will require subsequent welding at site shall be masked off after blast cleaning and left uncoated for a distance of 50 mm from all areas requiring welding. The masking material shall be removed as soon as possible after priming or painting. It shall be the Contractor's responsibility to ensure that all masking material is thoroughly removed from the equipment and any damage to the primed/painted surface is repaired prior to shipment.

5.1.4 Other Miscellaneous Requirements

In a multicoat system, a mist coat shall be applied over inorganic zinc primer to avoid surface defects. The Contractor shall exercise necessary care to ensure a smooth and uniform coating is applied over inorganic zinc primer.

Extra coats of paint shall be applied on areas where shape and/or plane of application results in thinly applied coating; e.g., at edges, welds behind angles, corners, etc. and areas not fully accessible by spray in order to obtain the specified coverage and thickness. A stripe coat of paint shall be brush applied before applying the subsequent coat. The sequence of stripe coating shall be decided during the pre-job conference of a project.

5.2 Scheduling

Unless otherwise recommended by the Manufacturer and accepted by the Owner, paints shall not be applied when :

- ◇ The surface temperature is less than 3 °C above dew point
- ◇ The surface temperature is below 5 °C as it could adversely affect the curing of paints.
- ◇ The relative humidity is more than 85%, except for Inorganic Zinc Silicate up to 90%.
- ◇ The metal surface temperature is higher than that recommended by the Manufacturer for application.
- ◇ Surface preparation has not been completed or oil, grease and dust are present on the substrate to be painted.
- ◇ Poor weather condition for painting exist or are expected within two hours of application such as blowing sand or rain.
- ◇ 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.
- ◇ Where the available light is less than 500 lux.

5.3 Application Methods

5.3.1 General

Coatings shall be uniformly applied without runs, sags, solvent blisters, dry spray or other blemishes. All blemishes and other irregularities shall be repaired or completely removed and recoated. Special attention, shall be paid to crevices, corners, edges, weld lines, bolt heads, nuts, and small brackets, to apply the specified minimum dry film thickness by brush application if spray will not completely cover all surfaces.

Edges of existing coating shall be feathered towards the substrate prior to overcoating.

Surface that will be inaccessible after assembly, including the surface of lap joint flanges, nozzle necks, lap joint stub ends, lap rings, bolt holds and some welded joints, shall receive the complete painting system before being assembled. Contact surface of bolted connections are to be primed only.

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.

Primers should not be overcoated with the second coat paint until the specified minimum overcoating time is achieved.

Intercoat contamination shall be minimised by maintaining proper cleanliness and by applying the intermediate and finish coats within the overcoating time recommended by the manufacturer. If contaminants are present, they shall be removed before applying succeeding coats.

Contrasting colour shall be used for each coat of paint.

Flanges, nozzles, clips, access ways saddles and other attachments which protrude through insulation shall be considered uninsulated and shall be painted in accordance with the coating system for external surface for the respective system.

Each coat shall be applied with acceptance limits of dry film thickness (dft) as specified in section 6.2 and 6.3. It must be ensured that solvent retention in any of the coats, caused by the application of excessive coating thickness is avoided.

The minimum dft of the specified coating systems shall always be complied with, even if this means application of more coats of paint.

Coatings intended to be exposed to continuous immersion in fresh water, salt water and brine shall be inspected for holidays in accordance with the methods recommended in ASTM D 5162.

5.3.2 Spray Application

Paints shall be applied by Air Spray or Airless Spray.

Hose and containers shall be thoroughly cleaned before addition of new materials. The spray gun shall be held no closer than 200 mm or more than 600 mm from the surface to be coated. During application the spray gun shall always be held at a right angle to the substrate. Each pass shall overlap the previous one by 50 percent. In order to achieve a uniform application, when large surface areas are being coated, spray application shall be made in two directions so that the passes are at right angles to each other i.e. cross spray at 50% over lapping. Pressures and spray fan shall be adjusted so that the optimum spray pattern is utilised for the surface being coated.

Opened paint container shall be properly covered when not in use' Opened paint container shall be properly covered when not in use.

5.3.3 Brush Application

Application with brush is acceptable under the following conditions subject to Owner approval:

- ◇ When areas cannot be properly coated by spray for any reason.
- ◇ When spray application is difficult due to location of work accessibility.
- ◇ Above ground level when it is considered that loss of paint under prevailing conditions is excessive e.g. windy and progress of work has to be maintained and personnel in or near the work site or equipment property, may be affected by spray particles.
- ◇ For touch-up or repair of localised damaged paint or to areas of incorrectly applied paint.
- ◇ For painting of stripe coat e.g. when applying the initial coat of paint to corners, edges, crevices, holes, welds or other irregular surface prior to spray application.
- ◇ When the substrate material to be applied are suitable for brush application.
- ◇ The number of coats shall be adjusted to the dry film thickness to match.

Paint brushes used shall be of a style and quality that will permit appropriate application of the material being applied.

Material applied by brush shall be smooth, uniform in thickness, without any apparent surface defects such as brush marks, runs, sags, or curtains.

5.3.4 Roller Application

Roller application shall only be used with written approval from the Owner.

Roller application may be used only when :

- ◇ Spraying is not feasible.
- ◇ Primer coat is applied by brush.
- ◇ Paint application by roller method is acceptable to paint manufacturer and is in accordance with the application data.

5.4 REPAIRS AND TOUCH UP PAINTING

5.4.1 General

Contractor shall submit, for approval by the Owner, a procedure for the repair and/or touch up painting of each generic coating system.

Before application of any further coat of material, all damages to previous coats shall be repaired. All loose paint shall be removed to a firm edge. All surface irregularities and contaminants shall be removed. Hard, glossy surfaces may require abrading to obtain a suitable surface for painting.

If the surface being prepared lies adjacent to a sound coated surface which is not to be repaired, the surface preparation shall overlap the coated surface by at least 25mm. The remainder of existing coated surface shall be properly protected with shields or screens to prevent any possible damage to the coating.

Inorganic zinc primer shall not overlap **with** adjacent intermediate and finish coats. Areas with inadequate coating thickness shall be thoroughly cleaned and if necessary, abraded, and additional compatible coats applied until they meet this specification. These additional coats shall blend in with the final coating on adjoining areas.

5.4.2 Coating Damage Not Exposing Substrate Surface

Surface to be overcoated which become contaminated or damaged shall be cleaned by solvent cleaning and/or lightly brush blasted to ensure that the surface is free of all contaminants. Contaminants shall be removed by dry compressed air and wipe by hand with clean, dry rags. The coating around the damaged area shall be chamfered by sanding to ensure continuity of the patch coating. The full coating system shall then be reapplied strictly in accordance with this specification.

5.4.3 Coating Damage Exposing Substrate Surface

The damaged area shall be recleaned to the original or maintenance painting system specified for that item and the full coating system reapplied in accordance with the application data. The recleaning shall carry over onto tightly adhering surrounding coating for not less than 25 mm all around and the edges shall be chamfered by sanding to ensure continuity of the patch coating.

5.4.4 Repair of Zinc Silicate Primer

Damaged surfaces of zinc primer shall be cleaned to remove all loose materials and blast cleaned with a portable vacuum blast cleaning unit. The surface shall be coated with one coat of the primer which is the same as the damaged primer.

If blast cleaning is not practical, power tool cleaning may be used subject to Owner and Contractor agreement. In such cases, subject to operating temperature limitations, one or two packs recoatable zinc primer may be used in lieu of zinc silicate primer subject to Owner and Contractor agreement.

5.4.5 Repair of Fully Cured Epoxy Coating

In case of repairing damage to fully cured epoxy coatings and/or painting of a fully cured and aged epoxy coating, the coating work shall only be carried out after the surface of the fully cured epoxy to be coated has been suitably abraded to provide an adequate anchor for the coating to be applied. The repair coating shall be compatible with the existing coating. A test for compatibility is described in ASTM D 5064.

5.4.6 Inadequate Coating Thickness

Areas with inadequate coating thickness shall be thoroughly cleaned and if necessary abraded and additional coats applied shall blend in with the final coating on adjoining areas.

5.4.7 Handling and Shipping of Coated Items

Coated items shall be carefully handled to avoid damage to coated surface. No handling shall be performed before the coating system is cured to an acceptable level. Packing, handling and storage facilities shall be of non metallic type.

6 PAINTING AND COATING SYSTEMS

6.1 COATING SYSTEMS SELECTION

6.1.1 General

The coating systems generally acceptable for the intended service are listed in Section 6.2 for external application and Section 6.3 for internal application. Selection and acceptance of coating systems and products for a specific and specialised application which are not listed herein shall be the prerogative of individual Owners in consultation with the respective Paint Manufacturers.

When selecting an approved product for a particular project, the Contractor in consultation with the Owner shall consider the following factors:

A. Coating characteristics

- ◇ Coverage cost (RM/m²)
- ◇ Application time
- ◇ Drying time
- ◇ Curing time
- ◇ Overcoating Time
- ◇ Recoating Time
- ◇ Compatibility

The maintenance and touch-up coating systems shall be compatible with the Initial/New Construction coating systems. Coating system compatibility shall be tested using patch test methods described in ASTM D 5064.

B. Nature of substrate

C. Basic Function of Coating on Substrate

D. Accessibility (time or space) and availability of appropriate equipment for satisfactory surface preparation and application.

E. Environmental factors.

F. Life Cycle Costs.

The coating systems shall demonstrate low Life Cycle Costs in combination with :

- ◇ an "Ideal/Optimum" Service Life of min. one (1) year for the first 10 - 12 years of service life and
- ◇ a "Practical" Service Life of min. ten (10) years.

The dry film thickness of the coating systems specified herein are minimum requirements to achieve the desired system performance.

6.1.2 Organic and Inorganic Zinc-Filled Coatings

The metallic zinc content in the zinc dust shall be minimum 94%.

Zinc content by percentage weight for inorganic zinc silicate and epoxy zinc should comply with SSPC-Paint 20. (Zinc rich primer, Type I 'Inorganic' and Type II 'Organic') requirement or equivalent.

Any new formulation related to zinc coating shall be subjected to qualification testing stated in this standard. The zinc coating systems shall pass the respective tests as shown in Appendix 7.

If shop primer (for temporary protection) is applied, then it must be 100% full blasted to the requirement stated in section 4 prior to the application of the full coating system.

For secondary surface preparation for primed surface:

All zinc salt formation shall be sweep blasted. All other possible contaminants shall be sanded down and solvent cleaned before topcoating. For damages, welding joints and rusty area, spot blast to Sa 2.5 followed by one coat of epoxy zinc rich or power tool cleaned to St3 and followed by Surface Tolerant epoxy - subject to Owner approval.

6.1.3 Selection and Application of Top Coats

For areas to be applied with polyester glassflake, all shop primer shall be removed completely, i.e. Sa 2.5.

Prior to topcoating zinc rich primers, SSPC-PS Guide 8 shall be consulted to select compatible topcoats. The selection process requires identification of the generic type of primer, compatibility considerations, and selection of compatible topcoats.

The minimum volume solids for high solid epoxy shall be 75%. As an alternative, a surface tolerant high solid epoxy paint can be applied.

When topcoating inorganic zinc silicate primed surface a mist coat (wet to wet technique) is required to eliminate pinholing.

6.2 PAINTING AND COATING SYSTEM SCHEDULES FOR EXTERNAL APPLICATION

6.2.1 Carbon Steel Design Temperature < 110 deg C NON INSULATED in the Atmospheric Zone

6.2.1.1 Coating System No. 1A : Initial Painting

Surface preparation : Blast Cleaning to ISO 8501-1 : 1988, Sa 2.5

Coating system		DFT	
1 st coat	Inorganic Zinc Silicate / Epoxy Zinc Rich	75	μ
2 nd coat	High Solid epoxy	150	μ
3 rd coat	Aliphatic polyurethane	50	μ
Total		275	μ

6.2.1.2 Coating System No. 1B : Maintenance Painting for Blast Cleaned Surface

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5

Coating system		DFT	
1 st coat	Epoxy zinc rich	75	μ
2 nd coat	High solid epoxy	150	μ
3 rd coat	Aliphatic polyurethane	50	μ
Total		275	μ

6.2.1.3 Coating System No. 1C : Maintenance Painting for Power Tool Cleaned Surface

Surface preparation : Power tool cleaning to ISO 8501-1: 1988, St 3

Coating system		DFT	
1 st coat	Surface tolerant HIGH SOLID epoxy	125	μ
2 nd coat	Surface tolerant HIGH SOLID epoxy	125	μ
3 rd coat	Aliphatic polyurethane	50	μ
Total		300	μ

6.2..2 Carbon Steel Design Temperature < 110 deg C INSULATED in the Atmospheric Zone

6.2.2.1 Coating System No. 2A : Initial Painting

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5

Coating system		DFT	
1 st coat	Inorganic zinc silicate / Epoxy zinc rich	75	μ
2 nd coat	High solid epoxy	150	μ
Total		225	μ

6.2.2.2 Coating System No. 2B : Maintenance Painting For Blast Cleaned Surface

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5

Coating system		DFT	
1 st coat	Epoxy zinc rich	75	μ
2 nd coat	High solid epoxy	150	μ
Total		225	μ

6.2.2.3 Coating System No. 2C : Maintenance Painting for Power Tool Cleaned Surface

Surface preparation : Power tool cleaning to ISO 8501-1 : 1988, St 3

Coating system		DFT	
1 st coat	Surface tolerant High Solid epoxy	125	μ
2 nd coat	Surface tolerant High Solid epoxy	125	μ
Total		250	μ

6.2.3 Offshore Platform Decks (including primary and secondary structures)

6.2.3.1 Coating System No. 3A : Initial Painting and Maintenance Painting

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5

Coating system		DFT	
1 st coat	Polyester Glass Flake	400	μ
2 nd coat	Polyester Glass Flake	400	μ
Antiskid aluminium oxide 20-30 mesh (0.85 - 0.60 mm)			
Total		800	μ

6.2.3.2 Coating System No. 3B : Initial Painting and Maintenance Painting (Alternative)

Surface Preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5

Coating system		DFT	
1 st coat	Epoxy glass flake	400	μ
2 nd coat	Epoxy glass flake	400	μ
Antiskid aluminium oxide 20-30 mesh (0.85 - 0.60mm)			
Total		800	μ

NOTE :

For maintenance painting, both Polyester Glassflake and Epoxy Glassflake can be applied in one coat application if antiskid is not required. The technical specification for Polyester Glassflake and Epoxy Glassflake are given in Appendix 2 and 3, respectively.

6.2.4 Splash Zone and Spray Zone

6.2.4.1 Coating System No. 4A : Initial Painting and Maintenance Painting

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5

Coating system		DFT	
1 st coat	Polyester glass flake	500	μ
2nd coat	Polyester glass flake	500	μ
Total		1,000	μ

6.2.4.2 Coating System No. 4B : Initial Painting and Maintenance Painting (Alternative)

Surface Preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5

Coating system		DFT	
1 st coat	Epoxy glass flake	500	μ
2nd coat	Epoxy glass flake	500	μ
Total		1,000	μ

Note

For major maintenance painting, one coat application of 1000 μ is allowed for polyester Glass Flake and epoxy glass Flake.

6.2.5 Carbon Steel Design Temperature > 110 deg C (INSULATED AND NON INSULATED) in the Atmospheric Zone

6.2.5.1 Coating System No. 5A : Initial Painting and Maintenance Painting

i) Coating System No. 5A(1) : Facilities with surface temperature 110 - 250 deg C

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5

Coating system		DFT	
1 st coat	Inorganic zinc silicate	75	μ
2 nd coat	Modified silicone acrylics	30	μ
3rd coat	Modified silicone acrylics	30	μ
Total		135	μ

ii) Coating System No. 5A(2) : Facilities with surface temperature 250 - 450 deg C

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5

Coating system		DFT	
1 st coat	Inorganic zinc silicate	75	μ
2 nd coat	Silicone aluminium	25	μ
3rd coat	Silicone aluminium	25	μ
Total		125	μ

NOTE :

Modified Silicone Acrylics and Silicone Aluminium shall be air-drying type.

If the operating temperature is in different range/class than the design temperature, then the selection of the coating system shall be considered on a case by case basis.

6.2.5.2 Coating System No. 5B : Maintenance Painting Power Tool Cleaned Surface

i) Coating System No. 5B(1) : Facilities with surface temperature 110 - 250 deg C

Surface preparation : Power tool cleaning to ISO 8501-1 : 1988, St 3

Coating system		DFT	
1 st coat	Zinc graphite	40	μ
2 nd coat	Modified silicone acrylics	30	μ
3rd coat	Modified silicone acrylics	30	μ
Total		100	μ

ii) Coating System No. 5B(2) : Facilities with surface temperature 250 - 450 deg C

Surface preparation : Power tool cleaning to ISO 8501-1 : 1988, St 3

Coating system		DFT	
1 st coat	Zinc graphite	40	μ
2 nd coat	Silicone aluminium	25	μ
3rd coat	Silicone aluminium	25	μ
Total		90	μ

NOTE

For isolated / spot touch up maintenance painting only.

Modified Silicone Acrylics and Silicone Aluminium shall be air-drying type.

6.2.6 GALVANISED STEEL

6.2.6.1 Coating System No. 6A : Initial Painting

Surface preparation : Degrease as SSPC-SP1 and wash with fresh clean water, light abrade or sweep blast surface to provide anchor pattern of 25 μ .

Coating system		DFT	
1 st coat	Surface tolerant High Solid epoxy	125	μ
2 nd coat	Aliphatic polyurethane	50	μ
Total		175	μ

Note

Hot dip galvanising shall be carried out in accordance with the requirements of BS 729: "Hot dipped galvanised coatings on iron and steel articles". A minimum of 610 gm/m² (dft 86 m) of zinc shall be applied. Maintenance of galvanised steel shall be treated as carbon steel as per this section 6.2.

6.2.7 STAINLESS STEEL

6.2.7.1 Coating System No. 7A : Initial Painting and Maintenance Painting

(i) Coating System No. 7A(1)

Non insulated facilities operating < 110 deg C

Surface preparation : Sweep blast with dry, non iron containing grit or roughen surface with emery paper to provide an anchor profile.

Coating system		DFT	
1 st coat	High Solid epoxy (refer to Note 1 below)	125	μ
2 nd coat	Aliphatic polyurethane	50	μ
Total		175	μ

(ii) Coating System No. 7A(2)

Insulated facilities operating < 110 deg C

Surface preparation : Sweep blast with dry, non iron containing grit / roughen surface with emery paper to provide an anchor profile

Coating system		DFT	
1 st coat	High Solid epoxy (Refer to Note 1 below)	125	μ
Total		125	μ

(iii) Coating System No. 7A(3)

Insulated and non insulated facilities operating 110 - 600 deg C

Surface preparation : Sweep blast with dry, non iron containing grit to create an anchor profile.

Coating system		DFT	
1 st coat	Silicone aluminium	25	μ
2nd coat	Silicone aluminium	25	μ
Total		50	μ

Note :

- 1) High solid epoxy should be non-inhibitive and non-metallic pigmented.

PAINING GUIDE FOR STAINLESS STEEL

Table below can be used as a guideline to select painting system for Stainless Steels.

Temp Range	Martensitic/Ferritic	Austentic	Duplex	Remarks
110°C upto 600°C	Coating System # 7A(3)	Coating System # 7A(3)	Coating System # 7A (3)	Insulated & non insulated
60°C upto 110°C	Coating System # 7A (2)	Coating System # 7A (2)	Coating System # 7A (2)	Insulated
	Coating System # 7A (1)	Coating System # 7A (1)	No Painting	Non-insulated
Upto 60°C	Coating System # 7A (2)	Coating System # 7A (2)	Coating System # 7A (2)	Insulated
	Coating System # 7A (1)	No Painting	No Painting	Non-insulated

6.2.8 Carbon Steel STORAGE TANK

6.2.8.1 Coating System No. 8A : Initial painting

Selection of initial painting systems for carbon steel storage tanks shall be made based on specific requirements of the relevant sections 6.2.1 through to 6.2.5.

6.2.8.2 Coating System No. 8B : Initial and MAINTENANCE PAINTING for Underside of Bottom plate (ONLY if painting is required for corrosion protection to supplement cathodic protection)

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5

Coating system		DFT	
1 st coat	Epoxy zinc rich	75	μ
2 nd coat	Coal tar epoxy	300	μ
Total		375	μ

6.2.8.3 Coating System No. 8C : Shell & roof plate, stairways, stair treads, gangways and others external parts include the piping (non galvanised)

The maintenance painting scheme shall follow that for carbon steel design temperature at $< 110^{\circ}\text{C}$.

The recommended Tank identification system is given in Appendix 4.

6.2.9 TIMBER DECKS

6.2.9.1 Coating System No. 9A : Initial and Maintenance Painting

Surface preparation : Light sanding to remove contaminant, sharp edges and old paints.

Coating system		DFT	
1 st coat	Aluminium wood primer	50	μ
2 nd coat	Alkyd semi-gloss finish	50	μ
3 rd coat	Alkyd semi-gloss finish	50	μ
Antiskid aggregate			
Total		150	μ

6.2.9.2 Coating System No. 10 : Markings

Surface preparation : Degrease and wash with clean fresh water. Abrade surface to provide another pattern.

Coating system		DFT	
Marking	Aliphatic polyurethane	50	μ
Total		50	μ

The recommended piping identification system and legend are given in Appendix 5 and 6, respectively.

6.2.11 Coating System No. 11 : Living Quarters, **Pressurised** Building, Control Room (Interior)

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5

Coating system		DFT	
1 st coat	Surface Tolerant Epoxy	150	μ
Total		150	μ

6.2.12 Coating System No. 6A : Initial Painting

Surface preparation : Degrease as SSPC-SP1 and wash with fresh clean water, light abrade or sweep blast surface to provide anchor pattern of 25μ.

Coating system		DFT	
1 st coat	Surface tolerant High Solid epoxy	125	μ
2 nd coat	Aliphatic polyurethane	50	μ
Total		175	μ

6.3 PAINTING AND COATING SYSTEM SCHEDULES FOR INTERNAL APPLICATION

6.3.1 Fuel Gas (Sweet & Sour)

Coating System No. 13a : Initial painting, Maintenance Painting for Blast Cleaned Surface and Power Tool Cleaned Surface.

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5, Power cleaning to ISO 8501-1 : 1988, St 3 for minor painting

Surface to be painted : All over

Service Temperature : Up to 60 °C

Coating system		DFT	
1 st coat	Amine Adduct Epoxy	125	μ
2 nd coat	Amine Adduct Epoxy	125	μ
Total		250	μ

6.3.2 Crude/Condensate (sweet & sour), Emulsion/Slop

6.3.2.1 Coating System No. 14a : Initial Painting, Maintenance Painting for Blast Cleaned Surface and Power Tool Cleaned Surface.

(i) Coating System No. 14a(1) : **Roof and Shell plate**

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5, Power tool cleaning to ISO 8501-1 : 1988, St 3 for minor touch-up painting

Service Temperature : Up to 60 °C

Coating system		DFT	
1 st coat	Amine Adduct Epoxy	125	μ
2 nd coat	Amine Adduct Epoxy	125	μ
Total		250	μ

Note :

Floating roof tank shell plates which are subjected to excessive abrasion and wear shall be uncoated. However, if the Owner Considers otherwise, suitable coating systems may be specified.

(ii) Coating System No. 14a(2) : **Bottom plate and Vessels**

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5, Power tool cleaning to ISO 8501-1 : 1988, St 3 for minor touch-up painting
Service Temperature : Up to 60 °C

Coating system		DFT	
1 st coat	Amine Adduct Epoxy	100	μ
2 nd coat	Amine Adduct Epoxy	100	μ
3 rd coat	Amine Adduct Epoxy	100	μ
Total		300	μ

(iii) Coating System No. 14A(3) : Alternative system for Bottom Plate

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5
Surface to be painted : **Bottom plate**
Service Temperature : Up to 60 °C

Coating system		DFT	
1 st coat	Epoxy Primer	50	μ
2 nd coat	Epoxy Glassflake	200	μ
3 rd coat	Epoxy Glassflake	200	μ
Total		450	μ

6.3.3 ***Light naptha, heavy naptha, treated naptha, reformate, jet A-1 fuel, lube oil, fuel oil, gasoline (unleaded), gasoline (leaded).***

6.3.3.1 Coating System No. 15a : Initial painting, Maintenance Painting for Blast Cleaned Surface and Power Tool Cleaned Surface.

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5, or Power tool cleaning to ISO 8501-1 : 1988, St 3 for minor painting
Surface to be painted : All over
Service Temperature : Up to 60 °C

Coating system		DFT	
1 st coat	Amine Adduct Epoxy	125	μ
2 nd coat	Amine Adduct Epoxy	125	μ
Total		250	μ

6.3.4 Diesel

6.3.4.1 Coating System No. 16a : Initial painting, Maintenance Painting for Blast Cleaned Surface and Power Tool Cleaned Surface.

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5, or Power tool cleaning to ISO 8501-1 : 1988, St 3 for minor painting

Surface to be painted : **Roof and Shell plate**
Service Temperature : Up to 60 °C

Coating system		DFT	
1st coat	Amine Adduct Epoxy	125	μ
2nd coat	Amine Adduct Epoxy	125	μ
Total		250	μ

Note :

Floating roof tank shell plates which are subjected to excessive abrasion and wear shall be uncoated. However, if the Owner considers otherwise, suitable coating systems may be specified.

6.3.4.2 Coating System No. 16b : Initial painting, Maintenance Painting for Blast Cleaned Surface and Power Tool Cleaned Surface.

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5, or Power tool cleaning to ISO 8501-1 : 1988, St 3 for minor painting

Surface to be painted : **Bottom plate and Vessels**
Service Temperature : Up to 60 °C

Coating system		DFT	
1 st coat	Amine Adduct Epoxy	100	μ
2 nd coat	Amine Adduct Epoxy	100	μ
3 rd coat	Amine Adduct Epoxy	100	μ
Total		300	μ

6.3.4.3 Coating System No. 16c : Alternative System for Bottom Plate

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5
Surface to be painted : **Bottom plate and Vessels**
Service Temperature : Up to 60 °C

Coating system		DFT	
1 st coat	Epoxy Primer	50	μ
2 nd coat	Epoxy Glassflake	200	μ
3 rd coat	Epoxy Glassflake	200	μ
Total		450	μ

6.3.5 Potable (drinking / aerated / non-aerated) Water, sea water (aerated / non-aerated), Produced Water, Brackish, Demineralised Water, Brine

6.3.5.1 Coating System No. 17a : Initial painting, Maintenance Painting for Blast Cleaned Surface and Power Tool Cleaned Surface.

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5, or Power tool cleaning to ISO 8501-1 : 1988, St 3 for minor painting

Surface to be painted : All over
Service Temperature : Up to 60 °C

Coating system		DFT	
1 st coat	Amine Adduct Epoxy	125	μ
2 nd coat	Amine Adduct Epoxy	125	μ
Total		250	μ

Note :

Coating system applied for potable water system shall be accompanied with a Health certificate.

6.3.6 Steam (condensate), Boiler Feed

6.3.6.1 Coating System No. 18a : Initial painting, Maintenance Painting for Blast Cleaned Surface and Power Tool Cleaned Surface.

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5, or Power tool cleaning to ISO 8501-1 : 1988, St 3 for minor painting

Surface to be painted : All over
Service Temperature : Up to 100 °C

Coating system		DFT	
1 st coat	Phenolic Epoxy	150	μ
2 nd coat	Phenolic Epoxy	150	μ
Total		300	μ

6.3.7 Utility Air

6.3.7.1 Coating System No. 19a : Initial painting, Maintenance Painting for Blast Cleaned Surface and Power Tool Cleaned Surface.

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5, or Power tool cleaning to ISO 8501-1 : 1988, St 3 for minor painting

Surface to be painted : All over
Service Temperature : Up to 60 °C

Coating system		DFT	
1 st coat	Amine Adduct Epoxy	125	μ
2 nd coat	Amine Adduct Epoxy	125	μ
Total		250	μ

6.3.7.2 Coating System No. 19B : Alternative System

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5
 Surface to be painted : All over
 Service Temperature : **Up to 60 °C**

Coating system		DFT	
1 st coat	Polyester Glassflake or Epoxy Glassflake	400	μ
		400	μ
Total		400	μ

6.3.7.3 Coating System No. 19C : Initial painting, Maintenance Painting for Blast Cleaned Surface and Power Tool Cleaned Surface.

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5, or Power tool cleaning to ISO 8501-1 : 1988, St 3 for minor painting
 Surface to be painted : All over
 Service Temperature : **More than 60 °C**

Coating system		DFT	
1 st coat	Phenolic Epoxy	125	μ
2 nd coat	Phenolic Epoxy	125	μ
Total		250	μ

6.3.7.4 Coating System No. 19D : Alternative System

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5
 Surface to be painted : All over
 Service Temperature : **More than 60 °C**

Coating system		DFT	
1 st coat	Vinyl Ester Glassflake	400	μ
		400	μ
Total			

6.3.8 Corrosion Inhibitors, Demulsifier, Oxygen Scavenger

6.3.8.1 Coating System No. 20a : Initial painting, Maintenance Painting for Blast Cleaned Surface and Power Tool Cleaned Surface

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5, or Power tool cleaning to ISO 8501-1 : 1988, St 3 for minor painting
 Surface to be painted : All over
 Service Temperature : **Up to 60 °C**

Coating system		DFT	
1 st coat	Vinyl Ester Glassflake	800-1500	μ
2 nd coat	Vinyl Ester Glassflake	800-1500	μ
Total		1600-3000	μ

6.3.9 Methanol & Percroethalyne

6.3.9.1 Coating System No. 21a : initial painting, Maintenance Painting for Blast Cleaned Surface and Power Tool Cleaned Surface.

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5, or Power tool cleaning to ISO 8501-1 : 1988, St 3 for minor painting

Surface to be painted : All over
Service Temperature : Up to 60 °C

Coating system		DFT	
1 st coat	Epoxy Phenolic	125	μ
2 nd coat	Epoxy Phenolic	125	μ
Total		250	μ

6.3.9.2 Coating System No. 21B : Alternative System

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5, or Power tool cleaning to ISO 8501-1 : 1988, St 3 for minor painting

Surface to be painted : All over
Service Temperature : Up to 60 °C
pH : 6-9

Coating system		DFT	
1 st coat	Inorganic Zinc Silicate	75-100	μ
Total		75-100	μ

6.3.10 Triethylene Glycol / Methylene Glycol

6.3.10.1 Coating System No. 22a : Initial Painting, Maintenance Painting for Blast Cleaned Surface and Power Tool Cleaned Surface.

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5, or Power tool cleaning to ISO 8501-1 : 1988, St 3 for minor touch-up painting

Surface to be painted : All over
Service Temperature : Up to 60 °C

Coating system		DFT	
1 st coat	Amine Adduct Epoxy	125	μ
2 nd coat	Amine Adduct Epoxy	125	μ
Total		250	μ

6.3.10.2 Coating System No. 22B : Alternative System

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5, or Power tool cleaning to ISO 8501-1 : 1988, St 3 for minor painting
Surface to be painted : All over
Service Temperature : Up to 60 °C

Coating system		DFT	
1 st coat	Epoxy Phenolic	125	μ
2 nd coat	Epoxy Phenolic	125	μ
Total		250	μ

6.3.10.3 Coating System No. 22C : Initial Painting, Maintenance Painting for Blast Cleaned Surface and Power Tool Cleaned Surface.

Surface preparation : Blast cleaning to ISO 8501-1 : 1988, Sa 2.5, or Power tool cleaning to ISO 8501-1 : 1988, St 3 for minor painting
Surface to be painted : All over
Service Temperature : More than 60 °C

Coating system		DFT	
1 st coat	Vinyl Ester Glassflake	400-500	μ
2 nd coat	Vinyl Ester Glassflake	400-500	μ
Total		800-1000	μ

6.3.11 Chemicals (Others)

6.3.11.1 Acids & Alkalis, Ammonia, Caustic Soda, Biocide, Chlorine, Descalers

In the event that there are large variations in the description of chemical cargo; the Owner shall consult the Paint Manufacturers for the selection of the most appropriate coating system to be applied. Typical information to be furnished by the Owner shall include :

- (a) Chemical action (concentration, pH, impurities or contaminants, chemical reactions, etc.)
- (b) Temperature (maximum, minimum, and operating, cycle e.g. steam out condition)
- (c) Pressure (maximum, minimum, and operating, cycle)
- (d) Environmental conditions (outside, inside, climate, accessibility)
- (e) Possibility of different cargo

The tank internals eg. attachments, etc. shall be coated with the same respective coating system.

6.4 PAINT MATERIALS STORAGE, SHELF-LIFE AND HANDLING

6.4.1 Storage

All containers containing paint materials shall be stored under cover giving protection from direct sunlight and rain at a temperature below 35°C. The storage condition should also allow for adequate ventilation to minimise paint container deterioration from humidity. Materials should be systematically stored after delivery so that a First-In-First-Out (FIFO) withdrawal procedure can be adopted.

6.4.2 Shelf-Life

The shelf-life quoted on product data sheets is generally a conservative value which takes into account the variable storage conditions encountered; and it is probable that paints can be applied without any compromise on its performance after the shelf life period has elapsed. However, if the quoted shelf-life period has been exceeded, it is recommended that the usability of the product shall be checked by the Manufacturer and notified to the owner. The procedure described in ASTM D 869 shall be used to evaluate degree of settling of paint.

Paint which has liveried, gelled, or otherwise deteriorated during storage shall not be used.

6.4.3 Handling

Many of the paints used in the oil and gas industry are heavy duty protective coatings supplied in 5 to 20 litres containers. Because of the weight of the containers, care must be taken in handling to avoid injury to the individual and damage to equipment. Palletised materials with mechanical handling should be used whenever possible.

When handling, damage can occur to the container and in severe cases leaks or spills of the paint may result. Damage to any container should be avoided to maximise storage and shelf-life of the paint.

6.5 COATING SYSTEM PRODUCT APPROVAL REQUIREMENT

New coating products, upgrading of existing product or formulation changes of approved coating products shall be submitted for a full laboratory screening before the product can be considered as an approved product.

Complete coating systems shall be tested and qualified in accordance with the procedures described in QP-CS1 : Procedure for Qualification and Testing of Coating Systems.

The PETRONAS Protective Coatings and Lining Technical Committee (PCLTC) recognizes a list of testing laboratories/bodies for conducting the various tests and evaluation of blast-cleaning abrasives and protective coating and lining systems. The list includes PETRONAS Research Sdn Bhd (PRSB), Agensi Nuklear Malaysia, Universiti Kebangsaan Malaysia (UKM), SIRIM and Det Norske Veritas (DNV) Singapore.

The PCLTC has the right to accept or reject test results or reports produced by other third party testing bodies or laboratories.

6.5.1 Test Panels

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 below; depending on the types of tests to be carried out.

The test panels shall be prepared in the field, for example in a coastal fabrication yard, to simulate field application condition where adverse climatic conditions may prevail. Each test panel shall be surface cleaned and coated to the requirement as prescribed in this specification.

All test panels should be kept indoors for a period of seven (7) days for curing before any testing.

6.5.2 Laboratory Testing

The test panels shall be submitted to PETRONAS Research & Scientific Services Sdn. Bhd. (PRSS) or other approved third party testing agency for laboratory testing.

Recommended laboratory test methods shall include, but not limited, to the following :

Types of Laboratory Tests			
Type	Test Method	Purpose	Acceptance Criteria
Salt Spray (Scribed)	ASTM B117 ASTM D1654 (Proc. A)	To study the creepage resistance of flawed coatings under accelerated conditions of the corrosive environment.	<u>Blast Cleaned Surface</u> 3,000 hr, coating defects as per ASTM D 1654 Proc. A, Rating 4-5 at scribe.
			<u>Power Tool Cleaned Surface</u> 3,000 hr, coating defects 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.	4,500 hr, coating defects as per ASTM D 1654 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 > 200 m.	500 psi (Splash Zone) 300 psi (Atmospheric Zone) To conduct 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 < 200 m.	For ASTM D3359 Method A : the acceptance criteria is 3A
Impact	ASTM D2794	To give a quantitative indication of the ability of paints to resist cracking due to impact loading.	18 J (Intrusion)
Abrasion	ASTM D4060	To assess quantitatively the abrasion resistance of the coatings.	150 mg/1000 cycles / 1kg load using wheel CS10
Water Immersion	ASTM D 870	To assess the water resistance of coatings by partial or complete immersion of coated specimens in distilled or de-mineralised water at ambient or elevated temperatures.	6000 hr without any visible coating defects.
Cathodic Disbonding	ASTM G 8	To assess resistance of coating to cathodic disbondment.	< 10 mm disbondment.
Accelerated Weathering	ASTM G 26	To study the effects of weather on coatings.	2,000 hours without any coating defects (except a max. degree of chalking rate of 6)
Heat-Resistance	ASTM D 2485, Test Method B	To evaluate the heat-resistant properties of coatings designed to protect steel surfaces exposed to elevated temperatures during their service life.	Gradual increase in temperature to the requirement as per specific requirement of section 6.2. Cool down the panel to room temperature before salt spray for 24hr. Result, without coating defect such as rust, blister & loss of adhesion

Types of Laboratory Tests			
Type	Test Method	Purpose	Acceptance Criteria
Cyclic Salt Fog/UV Exposure	ASTM D5894	To observe the performance of coatings subject to accelerated conditions of the cyclic corrosion/UV exposure : } Salt Spray duration 72 hrs } Drying in air duration 16 hrs } UV-A 340 nm duration 80 hrs } 25 cycles at 168 hrs/cycle	4,200 hrs, coating defects as per ASTM D1654 Proc. B, area failed Rating No. 9.
Note : Users may select ASTM D5894 test method to replace ASTM B117, ASTM D1654 and ASTM G 26.			

Polyurethane topcoated 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 D 523.

The coating systems, depending on their functions set forth in section 6.2 and 6.3, shall pass the respective tests as shown in Appendix 7. The final acceptance and approval of the coating systems tested shall be carried out in accordance with the process depicted in Appendix 8.

6.5.3 Product QA/QC Report

Paint Manufacturers shall submit QA/QC reports on the coating systems that passed the laboratory screening tests. The QA/QC reports must have the following information:

- ◇ Drying time
- ◇ Hold up property
- ◇ Glossiness
- ◇ Specific gravity
- ◇ Viscosity

Paint Manufacturers shall maintain that the properties of their coating systems selected for actual painting work will be the same as the ones that passed the laboratory screening tests. In this regard and if deemed necessary, paint manufacturers in consultation with the Owners, may be required to send their paint batches to PRSS or other approved third party testing agency to verify conformance to the QA/QC report stated herein.

Whenever considered deemed necessary, Owners may carry out a non-conformance audit on the paint manufacturers.

6.5.4 Paint Quality Control Batch Certificate

Paint manufacturers shall furnish their Paint Quality Control Batch certificates to ensure that the properties of the products supplied are consistent with the laboratory tested products.

As a minimum, the following information shall be provided : (i)

- Manufacturer's name
- (ii) Factory location
- (iii) Date of manufacture
- (iv) Batch number
- (v) Product name
- (vi) Generic name
- (vii) Key composition/components description :
 - ◇ Resin
 - ◇ Pigments
 - ◇ Curing Agent (generic name)
 - ◇ Solvent (generic name)
- (viii) QC Test Results including Test Standard, Pass Criteria, Actual Results;
 - ◇ Colour
 - ◇ Viscosity
 - ◇ Density/S.G.
 - ◇ Fineness
 - ◇ Drying Time
 - ◇ Hiding Power
 - ◇ Gloss

*All Quality Control test results shall be provided by paint manufacturer as and when requested by the Owner.

7 QUALITY CONTROL (QC)

7.1 INSPECTION

Compliance to this specification shall be controlled through inspection of each phase of a painting programme. Inspection is required during all phases of surface preparation and coating application.

The process map for the inspection activities is illustrated in Appendix 9.

7.2 PROJECT PRODUCTION TESTING

The purpose of project production testing is to check and test the Contractor to compliance and to demonstrate that the painting procedures, equipment and craftsmanship satisfy this specification and meet paint manufacturer requirement.

The production testing shall be conducted after the Fabricator /Contractor have selected the coating systems . The production testing shall not be used by the Fabricator / Contractor to qualify coating systems.

All observations, data and test results of the production trial shall be documented in preapproved agreed format; which shall include information such as painting contractor, type of cleaning and surface standards, generic coating materials, manufacturers and product brand names, batch number, blasting/painting environmental conditions, test results, etc.

The following tests shall be conducted by Contractor/Fabricator and witnessed by Owner's representative and Paint Vendors:

- ✦ Visual Inspection shall be carried out on each individual coat and completed coating system listing the appearance of the coating. The coating shall be free of run pinholes, cracking, blistering, sagging, crater, dry spray and over spray.
- ✦ Surface profile height shall be spot checked and documented using an approved surface profile gauge (e.g. Elcometer 123)
- ✦ Film thickness measurement for both wet film thickness and dry film thickness shall be conducted during all coating application sequences (i.e. individual coats and specified total dry film thickness). Wft and Dft measurement shall comply to ASTM D4414 and SSPC-PA2, respectively.
- ✦ Adhesion Test shall be performed on a flat surface in accordance with ASTM D4541
Standard test method for pull-off strength of coating using hydraulic adhesion tester for coating total dft above 200 microns. Adhesion test on final coat or complete coating system shall be conducted after curing for a minimum of seven (7) days. Degree of curing
for Inorganic Zinc coatings shall be determined using the method described in ASTM D 4752. The recommended minimum "pull-off" value for glassflake coating system is 500 psi and all other coating systems, shall be minimum 300 psi.
- ✦ For coating dft less than 200 microns (mainly reference to single pack coatings), power tool cleaned surface (maintenance system) galvanized steel, aluminium & stainless steel, the X-cut technique, and the use of pressure sensitive adhesive tapes to the cut surface shall be used. The X-cut test shall be carried in accordance to ASTM D3359 Method A
Standard test method for measuring adhesion by tape test.

All areas of coatings that have been damaged due to the destructive tests shall be repaired immediately.

8 RESOURCE REQUIREMENT

8.1 PAINTING CONTRACTOR

Painting contractors shall have the personnel, organisation, qualifications, procedures, knowledge and capability to produce surface preparation and coating application of the required quality for complex structures. The procedure for evaluating qualifications of painting contractors are described in SSPC-QP1.

Functional areas to be evaluated shall include the following:

- ◇ Management procedures;
 - ✦ Company Policy,
 - ✦ Organisation and Personnel,
 - ✦ Administrative and Management Procedures,
- ◇ Technical Capabilities;
 - ✦ Personnel Qualifications,
 - ✦ Technical Resources,
 - ✦ Procedures,
 - ✦ Equipment, Facilities, and Experience,
- ◇ Quality Control;
 - ✦ Personnel Qualifications,
 - ✦ Inspection Procedures and Recording Systems,
- ◇ Safety;
 - ✦ Safety Procedure and Record - Keeping Systems,
 - ✦ Resource Materials

8.2 PAINTING INSPECTOR

All painting inspection shall be carried out by certified personnel described in 8.2.1 below.

8.2.1 Qualifications/Experience

The Painting Inspector shall be certified under either one (1) of the following certification institutes :

(i) Institute of Materials, Malaysia (IMM), Level II

(ii) NACE International Certified

(iii) Other reputable Institutes e.g. SSPC, FROSIO, ICorr, etc.

He shall have at least three (3) years experience in painting inspection, and a good working knowledge on all aspects of painting : procedures, specification, paint performance and application as well as inspection. He shall be able to use paint inspection tools which are normally associated with the works.

8.2.2 Responsibilities

The Painting Inspector is held responsible for ensuring that the quality of all aspects of a painting programme is correct and according to this specification.

The Inspector's duty is to ensure that the requirements of the coating specification are met. ASTM D3276-86 Standard Guide for Painting Inspectors (Metal Substrates) or SSPC Publication #91-12 Coating & Lining Inspection Manual, Section 2 shall be referred to by the Inspector at all times as an information aid in carrying out his task efficiently.

The Inspector's function is to enforce the specifications without exception even if he deems them to be inadequate and to consult the Owner's QA/QC Engineer of any deviations.

Besides specification enforcement, the Painting Inspector shall be responsible for witnessing, verifying, and documenting the work at various inspection points :

- ◇ Pre-surface preparation inspection.
- ◇ Measurement of environmental conditions.
- ◇ Evaluation of compressor (Air cleanliness) and surface preparation equipment.
- ◇ Determination of surface preparation cleanliness and profile.
- ◇ Inspection of application equipment.
- ◇ Witnessing paint mixing.
- ◇ Inspecting paint / application.
- ◇ Determination of wet film thickness.
- ◇ Determination of dry film thickness.
- ◇ Evaluating cleanliness between coats.
- ◇ Pinhole and holiday testing.
- ◇ Adhesion testing.
- ◇ Evaluating the curing of applied paints.
- ◇ Any other coating related activities

8.3 BLASTER/PAINTER

8.3.1 Qualifications / Experience

Blaster/Painter shall be a IMM certified Protective Coatings Technician Level 1 or Level 2 or Akademi Binaan Malaysia / Construction Industry Development Board (ABM-CIDB) certified blasters and painters, qualified to do blasting & painting work as required by the Owners. He shall be competent and skilful with the following operations :

- ◇ Blasting;
 - ✦ Equipment Set Up (Type of Nozzle, Compressor Pressure, Type of Hose, After Cooler).
 - ✦ Abrasive (Type, Size).
 - ✦ Surface Quality Achieved.
- ◇ Painting;
 - ✦ Equipment (Application Method, Air Pressure, Tip Size)
 - ✦ Paint Used (Product used, Generic name, Mixing Ratio, Mixing Method, Thinner, Percent thinning, Expected Pot Life, Thickness required)

He shall have a minimum of two (2) years experience in blasting and / or painting.

8.3.2 Responsibilities

Level 1 Technician shall be allowed to carry out either blasting or painting work depending on his category of certification.

Level 2 Technician shall be allowed to carry out both blasting and painting works

Performance of all blasting and painting works shall be under the supervision of the Painting Inspector.

8.3.3 General Requirements and Working conditions

Both Level 1 and Level 2 Protective Coating Technicians should be capable of working effectively from scaffolding or temporary structures and at heights up to 100 feet above water.

8.4 PAINT SUPPLIER COATING ADVISOR

8.4.1 Qualifications / Experience

A Coating Advisor shall possess as a minimum a Diploma in Chemistry or equivalent engineering qualification or a minimum five (5) years field experience in blasting and painting operation with intensive paint manufacturer internal training.

8.4.2 Responsibilities

His responsibilities are the following :

- ◇ Educate and demonstrate on correct application methods of new paint products to Protective Coating Technician whenever deemed necessary.
- ◇ Provide technical advice during pre-job meeting.
- ◇ Clarify dispute on quality of paint materials delivered to work site.
- ◇ Advice HSE Officer on matters related to handling and disposal of paint materials.

8.5 INSPECTION EQUIPMENT

The painting inspection equipment shall be provided by the Inspection agency and the Contractor. The appropriate instruments with valid calibration where applicable, to be used at various inspection points are, but not limited to :

Item No.	Item Description	Purpose
1	Sling Psychrometer	Weather Condition Check
2	Surface Thermometer 0 °C to 150 °C	
3	Psychrometric Tables	
4	Hypodermic Needle Pressure Gauge	Blasting Equipment Check
5	Blast Nozzle Aperture Gauge	
6	Surface Profile Gauge	Surface Quality Check
7	Surface Preparation Standards	
8	Inspection Mirror	
9	Illuminated Magnifier	
10	Salinity Refractometer / Salt Contamination Meter	Paint Thickness Check
11	WFT Gauge	
12	DFT Gauge for Ferrous or non-ferrous	Holiday Detection
13	Low Voltage Holiday Detector	
14	High Voltage Holiday Detector	Adhesion Check
15	Cutter for Tape Adhesion Test	
16	Hydraulic Adhesion Tester	

9. HEALTH, SAFETY AND ENVIRONMENT (HSE)

9.1 SAFETY AND HEALTH REGULATIONS

Owners shall have a stake in ensuring that contractors employed have the capability to comply with health and safety regulations, and that hazardous operations in the protective coatings industry are recognised such as :

- (a) Materials;
 - ◊ Fire Hazards and Explosions
 - ◊ Health Hazards
- (b) Paint Application;
- (c) Surface Preparation;
- (d) Access and Rigging;
 - ◊ Ladders
 - ◊ Fall Hazards
 - ◊ Confined Spaces
- (e) Equipment Grounding

Contractor shall submit and has full responsibility for maintaining a proper and sufficient safety loss and prevention programme covering the work and covering the employees.

Contractor Safety and Health Programmes shall be designed to comply with PETRONAS Corporate Policy Statement on Health, Safety & Environment (Appendix 10), the Malaysian National Council for Occupational Safety and Health Act (OSHA), 1994 which states that it shall be the duty of every employer and every self-employed person to ensure, as far as practicable, the safety, health and welfare at work of all his employees.

The purpose of an OSHA Compliance Programme is to make further provisions for securing that safety, health and welfare of persons at work, for protecting others against risks to safety or health in connection with the activities of persons at work.

The components of an OSHA Compliance Programme shall include:

1. Policy statement establishing goals and commitment of management and the means for communicating these to all employees.
2. Delegation of responsibilities for implementing the programme.
3. Methods for identifying hazards and hazardous activities and for controlling them.
4. Commitment to ongoing training and education of all supervisors and employees on all aspects of job safety and health.
5. Proper reporting and record keeping, and investigation of all accidents, injuries and illness.
6. Methods and procedures for complying with specific OSHA regulations.
7. Periodic review of the programme with revisions made as necessary.

ENVIRONMENTAL REGULATIONS

Painting and coating activities have a significant effect on the environment. Some examples of these activities and their specific effects are:

(a) Abrasive Blast Cleaning

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 dust generation shall be in compliance with the Environmental Quality (Clean Air) Regulations 1989.

(b) Paint Application

In the process of spraying, a substantial portion of the liquid coating does not reach 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.

(c) Waste Production

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 the heavy metal (e.g., lead) content of the residue, or the solvents of unused paint or thinner.

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

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

(d) Product Storage

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.

(e) Leaching of Coatings

Under certain circumstances, toxic or otherwise undesirable components of applied coating films may leach into the environment.

The above activities collectively can affect almost all the major environmental receptors i.e. air, soil, groundwater, surface water, potable water.

Contractor Environmental Programme shall comply with the Malaysian Environmental Quality Act (EQA), 1974 relating to the prevention, abatement, control of pollution and enhancement of the environment.

Contractors hired to remove hazardous paint 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 Paint Removal;
- (ii) Technical Capabilities;
- (iii) Qualification of Personnel; and
- (iv) Safety and Health.

10 COLOUR SCHEMES

10.1 COLOUR SCHEME FOR ONSHORE/OFFSHORE INSTALLATION Colour

scheme for Onshore/Offshore Installation is as per Appendix 11.

Where applicable, colour schemes shall be in accordance with local statutory rules and regulations and customs specific to the Owner's individual requirements.

If an intermediate coat has to be applied, it should be applied a shade lighter than the top coat in order to increase the inspectability.

10.2 COLOUR IDENTIFICATION FOR STORAGE TANK

Colour identification should be painted on a square (1m x 1m)* at the tank shell in position which is easily visible. The colour scheme shall be specific to the Owner's individual requirements.

For easy reference, the product contents and the tank number should be worded above the colour identification square box. The size of the lettering and the location is described in Appendix 4.

10.3 IDENTIFICATION OF PIPING SYSTEM

Identification may be accomplished by stenciling, the use of tape or markers. In any situations, the detail dimensions, number and location of identification markers shall be based on the particular piping system as specified in Appendix 5 and 6.

For other systems not described in Appendix 5 and 6, the owner shall determine them as appropriate basing on ANSI 13.1 - Scheme for identification of Piping System.

10.4 SAFETY COLOURS

Where appropriate for safety reasons, the following colour scheme shall be adopted.

Items	Colour Scheme	BS 4800
Dangerous obstructions	Black and OSHA Yellow (in alternate bands)	00-E-53/
Dangerous or exposed parts of	Alert (OSHA) Orange	
Fire Equipment and services	OSHA Red	
First Aid equipment	OSHA Green	
Foam System	OSHA Yellow	
Flare Stack/Communication Towers	OSHA Orange/White (in alternate bands)	/00-E-55

11 REFERENCES

The standards referenced in this specification are listed in sections 11.1, 11.2, 11.3 and 11.4 and shall form part of this specification. The latest issue, revision, or amendments of the reference standards shall govern unless otherwise specified. In the event of any conflict between this specification and the requirements of any of the standards and/or publications referred , the requirements of this specification shall prevail.

11.1 NACE INTERNATIONAL STANDARDS AND PUBLICATIONS

Standard/Publication No.	Description
NACE No. 2/SSPC-SP 10	Near-White Metal Blast Cleaning
NACE No. 3/SSPC-SP 6	Commercial Blast Cleaning
NACE No. 5/SSPC-SP 12	Surface Preparation and Cleaning of Steel and Other Hard Materials by High- and Ultrahigh-Pressure water Jetting Prior to Recoating
NACE Publication 6G186	Surface Preparation of Contaminated Steel Surfaces
NACE RP 0181-94	Liquid-Applied Internal Protective Coatings for Oil field
NACE Publication 6A192	Dehumidification Equipment in Lining Application

11.2 STEEL STRUCTURES PAINTING COUNCIL

Standard/Publication No.	Description
SSPC-Guide to Vis 1-89	Visual Standard for Abrasive Blast Cleaned Steel
SSPC-SP 1	Solvent Cleaning
SSPC-SP 11	Power Tool Cleaning to Bare Metal
SSPC-AB 1	Mineral and Slag Abrasives
SSPC-PA 2	Measurement of Dry Paint Thickness with Magnetic Gauges
SSPC-PS Guide 8	Guide to Topcoating Zinc-Rich primers
SSPC-QP 1	Standard Procedure For Evaluating The Qualifications of
SSPC-QP 2(I)	Standard Procedure For Evaluating The Qualifications of
SSPC-Paint 20	Zinc rich primer, Type I 'Inorganic ' and Type II 'Organic'

11.3 AMERICAN SOCIETY FOR TESTING & MATERIALS (ASTM)

Standard No.	Description
Preparation of Surfaces For Painting	
ASTM D 4285	Standard Test Method For Indicating Oil or Water in Compressed Air
ASTM D 4417	Standard Test Methods For Field Measurement of Surface Profile of Blast
ASTM E 337	Standard Test Method For Measuring Humidity with a Psychrometer (the
Physical Properties - Liquid Paints	
ASTM D 869	Standard Test Method For Evaluating Degree of Settling of Paint
Physical Properties - Cured Films	
ASTM D 3359	Standard Test Methods For Measuring Adhesion by Tape Test
ASTM D 4541	Standard Test Method For Pull-Off Strength of Coatings Using Portable
ASTM D 4752	Standard Test Method For Measuring MEK Resistance of Ethyl Silicate
Thickness Measurement	
ASTM D 4414	Standard Practice for Measurement of Wet Film Thickness by Notch Gauges
Visual Examination and Appearance	
ASTM D 610	Test Method For Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM D 4214	Standard Test Methods For Evaluating Degree of Chalking of Exterior Paint Films
General Topics	
ASTM D 523	Standard Test Method for Specular Gloss
ASTM D 870	Standard Practice for Testing Water Resistance of Coatings Using Water
ASTM D 2485	Standard Test Methods for Evaluating Coatings For High Temperature
ASTM D 3276	Standard Guide For Painting Inspectors (Metal Substrates)
ASTM D 5064	Standard Guide for Conducting a Patch Test to Assess Coating
ASTM D 5162	Standard Practice For Discontinuity (Holiday) Testing of Non-conductive
ASTM G 8	Standard Test Methods for Cathodic Disbonding of Pipeline Coatings

11.4 INTERNATIONAL STANDARDS

Standard /Publication No.	Description
ISO 12944-1	<i>Paints and varnishes-Corrosion protection of steel structures by paint systems. Part 1: General introduction</i>
ISO 12944-2	<i>Paints and varnishes-Corrosion protection of steel structures by paint systems. Part 2: Classifications of environments</i>
ISO 12944-3	<i>Paints and varnishes-Corrosion protection of steel structures by paint systems. Part 3: Design and constructive requirements</i>
ISO 12944-4	<i>Paints and varnishes-Corrosion protection of steel structures by paint systems. Part 4: Surface types and preparation</i>
ISO 12944-7	<i>Paints and varnishes-Corrosion protection of steel structures by paint systems. Part 7: Execution and supervision of painting work</i>
ISO 12944-8	<i>Paints and varnishes-Corrosion protection of steel structures by paint systems. Part 8: Development of specifications for new and maintenance work</i>
ISO 20340	<i>Paints and varnishes-Performance requirements for protective paint systems for offshore and related structures.</i>
ISO 11124-2 to 4	<i>Preparation of steel substrates before application of paints and related products. Specifications for metallic blast-cleaning abrasives</i>
ISO 11125-1 to 7	<i>Preparation of steel substrates before application of paints and related products. Methods for testing metallic blast-cleaning abrasives</i>
ISO 11126-3	<i>Preparation of steel substrates before application of paints and related products. Specifications for non-metallic blast-cleaning abrasives: copper refinery slag</i>
ISO 11126-6	<i>Preparation of steel substrates before application of paints and related products. Specifications for non-metallic blast-cleaning abrasives: iron furnace slag</i>
ISO 11126-7	<i>Preparation of steel substrates before application of paints and related products. Specifications for non-metallic blast-cleaning abrasives: fused aluminium oxide</i>
ISO 11126-8	<i>Preparation of steel substrates before application of paints and related products. Specifications for non-metallic blast-cleaning abrasives: olivine sand</i>
ISO 4624	<i>Paints and varnishes. Pull-off test</i>
ISO 11127-1 to 7	<i>Preparation of steel substrates before application of paints and related products. Methods for testing non-metallic blast-cleaning abrasives</i>
ISO 8501-1	<i>Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings</i>
ISO 8501-2	<i>Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Part 2: Visual assessment of surface cleanliness</i>
ISO 8501-3	<i>Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Part 3: Preparation grades of welds, cut edges and other areas with surface imperfections</i>
ISO 8502-1 to 4	<i>Preparation of steel substrates before application of paints and</i>

	related products. Tests for the assessment of surface cleanliness
ISO 8502-6	Preparation of steel substrates before application of paints and related products. Tests for the assessment of surface cleanliness: extraction of soluble contaminants for analysis-The Bresle method
ISO 8502-9	Preparation of steel substrates before application of paints and related products. Tests for the assessment of surface cleanliness: Field method for conductometric determination of water-soluble salts.
ISO 8503-1 to 4	Preparation of steel substrates before application of paints and related products. Surface profile of abrasive blast-cleaned steel
ISO 8504-1 to 3	Preparation of steel substrates before application of paints and related products. Methods for surface preparation
ISO 4578	Adhesives. Determination of peel resistance of high-strength adhesive bonds
ISO 1513	Paints and varnishes. Examination and preparation of samples for testing
ISO 19840	Paints and varnishes. Determination of dry film thickness. Nondestructive magnetic flux method
ISO 2409	Paints and varnishes. Cross-cut test
ISO 7253	Paints and varnishes. Determination of resistance to neutral salt spray
ISO 787-10	General methods of test for pigments and extenders - Part 10: Determination of density. Pyknometer method
ISO 2812-1	Paints and varnishes - Determination of resistance to liquids Part 1: General method
ISO 2812-2	Paints and varnishes - Determination of resistance to liquids Part 2: Water immersion method
ISO 6270	Paints and varnishes - Determination of resistance to damp (continuous condensation)
ISO 4628-1	Evaluation of paint and varnish defects. Designation of intensity, quantity and size of common types of defect - Part 1: General principles and rating schemes
ISO 4628-2	Evaluation of paint and varnish defects. Designation of intensity, quantity and size of common types of defect - Part 2: Designation of degree of blistering
ISO 4628-3	Evaluation of paint and varnish defects. Designation of intensity, quantity and size of common types of defect - Part 3: Designation of degree of rusting
ISO 4628-4	Evaluation of paint and varnish defects. Designation of intensity, quantity and size of common types of defect - Part 4: Designation of degree of cracking
ISO 4628-5	Evaluation of paint and varnish defects. Designation of intensity, quantity and size of common types of defect - Part 5: Designation of degree of flaking
ISO 4628-6	Evaluation of paint and varnish defects. Designation of intensity, quantity and size of common types of defect - Part 6: Rating of degree of chalking by tape method
ISO 9223	Corrosion of metals and alloys. Atmospheres corrosivity classification
ISO 3678	Paints and varnishes. Print-free test
ISO 7724-1 to 3	Paints and varnishes. Determination of colour and colour difference

11.5 AMERICAN NATIONAL STANDARD INSTITUTE

Standard /Publication No.	Description
ANSI 13.1	Scheme For Identification of Piping System

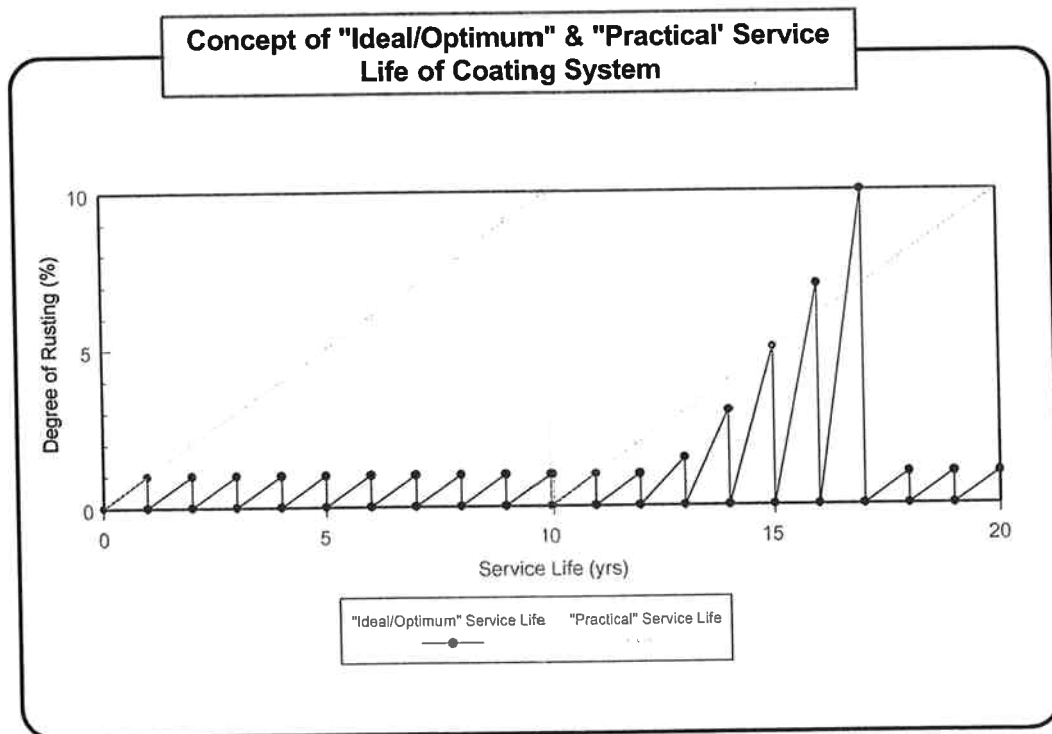
APPENDIX 1	GUIDELINE ON MAINTENANCE PAINTING CRITERIA AND EXPECTED COATING PERFORMANCE
APPENDIX 2	GLASS FLAKE POLYESTER GENERIC SPECIFICATION
APPENDIX 3	GLASS FLAKE EPOXY GENERIC SPECIFICATION
APPENDIX 4	STORAGE TANK IDENTIFICATION SYSTEM
APPENDIX 5	PIPING IDENTIFICATION SYSTEM
APPENDIX 6	PIPING COLOUR IDENTIFICATION LEGEND
APPENDIX 7	COATING SYSTEMS TESTING REQUIREMENTS
APPENDIX 8	COATING SYSTEM APPROVAL PROCESS FLOW
APPENDIX 9	FLOWCHART FOR INSPECTION OF BLASTING AND PAINTING ACTIVITIES
APPENDIX 10	PETRONAS CORPORATE POLICY - STATEMENT ON HEALTH, SAFETY AND ENVIRONMENT
APPENDIX 11	COLOUR SCHEME FOR ONSHORE/OFFSHORE INSTALLATION & EQUIPMENT

APPENDIX 1 - GUIDELINE ON MAINTENANCE PAINTING CRITERIA AND EXPECTED COATING PERFORMANCE

A) MAINTENANCE PAINTING CRITERIA

The objective of this guide is to assist the Owner in ensuring a high standard in code of practices to assure high coating performance, whether in new construction or maintenance painting. A contractual arrangement may be necessary whereby the Contractor (or paint manufacturer) are required to supply and apply the paints.

Following completion of a new construction or major maintenance painting, a touch up painting shall be carried out. Touch up painting or spot repairs shall be carried out before or at the expiry of the "Ideal/Optimum" service life of the coating systems; while complete repainting shall be carried out at or after the expiry of the "Practical" service life of the coating systems, as illustrated in the graph below.



The maintenance criteria recommended is stipulated in the table below.

Paint Coating Failure Types	Assessment Standard ASTM	Category of Painting			
		No Maintenance req'd for 2 yrs or longer	Spot Repair Only	Spot Repair Plus Topcoat	Complete Repaint
Rusting	D 610	Rust Grade 10 ($< 0.01\%$ rusting)	Rust Grade 9 - 6 ($< 1\%$ rusting)	Rust Grade 5 - 4 ($1 - 10\%$ rusting)	Rust Grade 3 - 0 ($> 10\%$ rusting)

B) EXPECTED COATING PERFORMANCE

A facility coated with a reasonable coating system and applied with good workmanship and regular maintenance carried out is expected to perform for a certain duration of time.

The table below serves as a recommendation and a guide for the Owner to determine total recoating interval, dependent on his intended maintenance frequency and quality of maintenance based on the coating system proposed as per Section 6.2.

Classification	Rate of Rusting (ASTM D 610) (% per yr.)	Spot Repairs Interval (yrs)	Spot Repairs Plus Topcoating Interval (yrs)	Total Repainting Interval (yrs)
Type I	0.5	max. 2	2 - 15	min. 15
Type II	1	max. 1	1 - 10	min. 10
Type III	2	max. 0.5	0.5 - 5	min. 5

NOTE :

For Type III classification, lower quality coating system than specified in Section 6.2 may be used, especially for facilities of lesser importance or marginal field projects.

However, the Owner may consider to carry out total recoating in lesser period than the above guideline based on other consideration, e.g. :

1. Making full use of the resources meant for other maintenance e.g. scaffolding.
2. Coincide with a major shutdown or revamp project.
3. Other critical issues.

APPENDIX 2 - GLASSFLAKE POLYESTER GENERIC SPECIFICATION

A. Polyester Glassflake

This specification establishes the minimum requirements of a glassflake filled polyester coating. This is recommended to be applied for both topsides and splash zone.

1. Type of Polyester

The polyester resin shall be either Bisphenol A or Isophthalic.

2. Wax Content

A wax-free coating is preferred. Where wax layers are unavoidable, the wax content shall be as low as possible. The maximum content shall be 0.1% (wt).

3. Glass Flakes

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 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.

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.

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.

4. Application Properties

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" or "sags" and in one spray application.

5. Volume Solids

The product shall have a volume solid of 95% minimum.

6. Pigment Content

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.

7. Shelf Life / Pot Life

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.

8. Drying Time

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.

9. Hardness

The Barcol hardness shall be within the range of 35 - 45 as measured in accordance with ASTM D2583.

10. 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.

11. 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

	<u>Minimum Requirement</u>	
- Tensile strength (test speed 50 mm/min)	30	N/mm ²
- Elongation	0.9	%

The coefficient of thermal expansion shall be in the same order as that of steel i.e. between $10-90 \times 10^{-6}/^{\circ}\text{C}$.

12. 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.

13. 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.

14. 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.

15. Safety

The Manufacturer shall provide the Owner and the relevant applicator with a valid Materials Safety Data Sheets (MSDS).

APPENDIX 3 - GLASSFLAKE EPOXY GENERIC SPECIFICATION

B. Epoxy Glass Flake

This specification establishes the minimum requirements of an epoxy glassflake filled coatings recommended for application on both topsides and splash zone. The required dry film thickness shall be 800 microns.

1. Type Of Epoxy

The epoxy resin will be based on liquid epoxy.

2. Glass Flake

The glassflake used shall be of the chemical resistance type 'C' glass. The minimum content shall be 10% by weight. The minimum thickness of the glass flake shall be 5 ± 2 microns with an average length of 400 microns in any direction of the planar 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.

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.

3. 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 is also advisable to check that adequate air volume is present, otherwise a consistent spray fan will not be obtained.

4. Volume Solids

The product should have a minimum volume solids of 90%.

5. 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.

6. Drying Times

The product shall hard dry within 4 to 10 hours at temperature range of 25° to 40° C.

7. Hardness

The Barcol hardness shall be within the range of 40 - 50 as measured in accordance with ASTM D2583. (Model GYZJ 935)

8. 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.

9. Other Properties

Other properties required to achieve good mechanical properties are as follows :-

Tensile Strength (ASTM D2370)	-	10 M Pa (1450 psi.)
Elongation (ASTM D2370)	-	2%

The coefficient of thermal expansion shall be in the same order as that of steel i.e. between $10-90 \times 10^{-6}/^{\circ}\text{C}$.

10. 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.

11. 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.

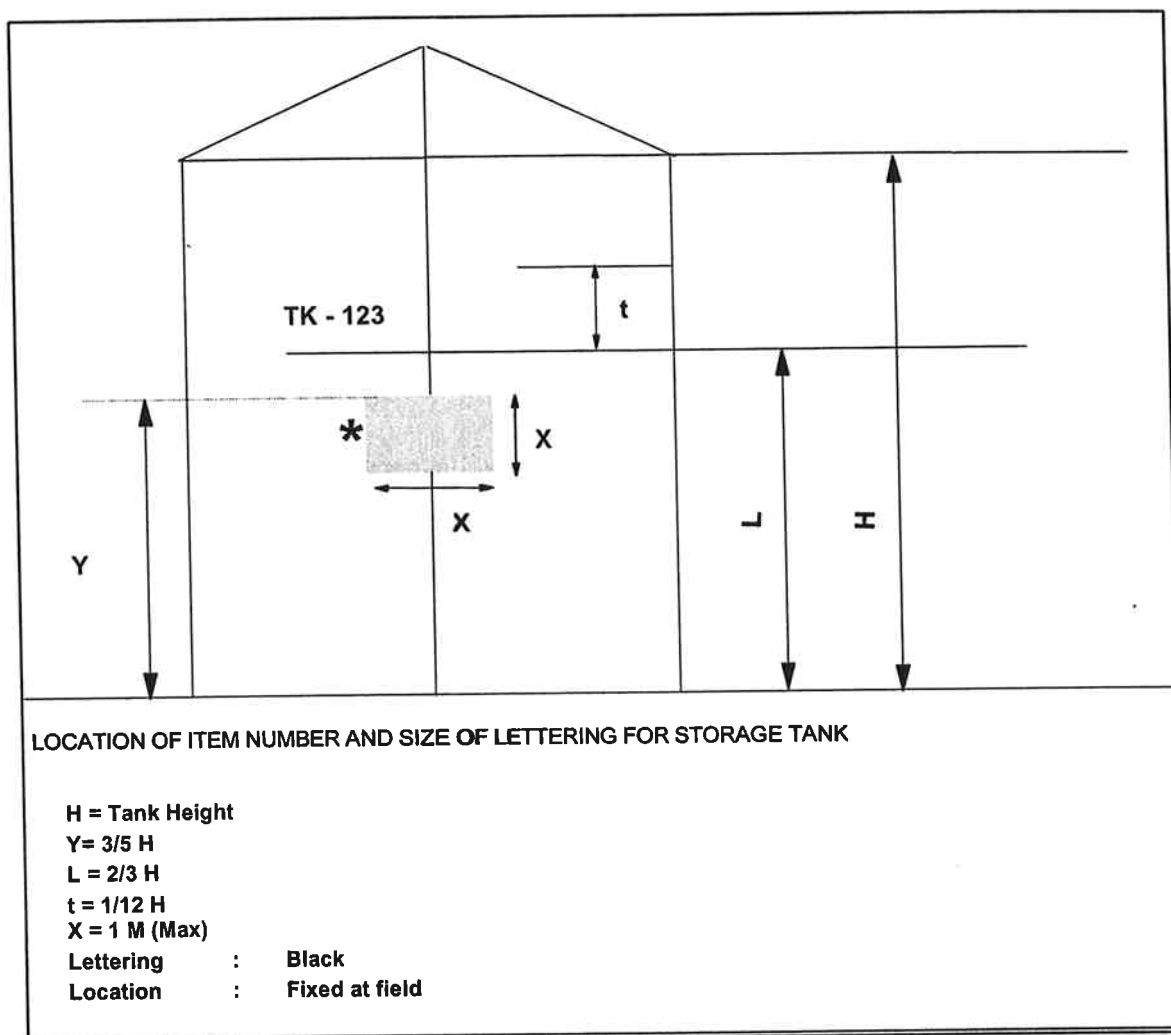
12. Cathodic Disbondment Test

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.

13. Safety

The Manufacturer shall provide the Owner and the relevant applicator with a valid Materials Safety Data Sheets (MSDS).

APPENDIX 4 – STORAGE TANK IDENTIFICATION SYSTEM



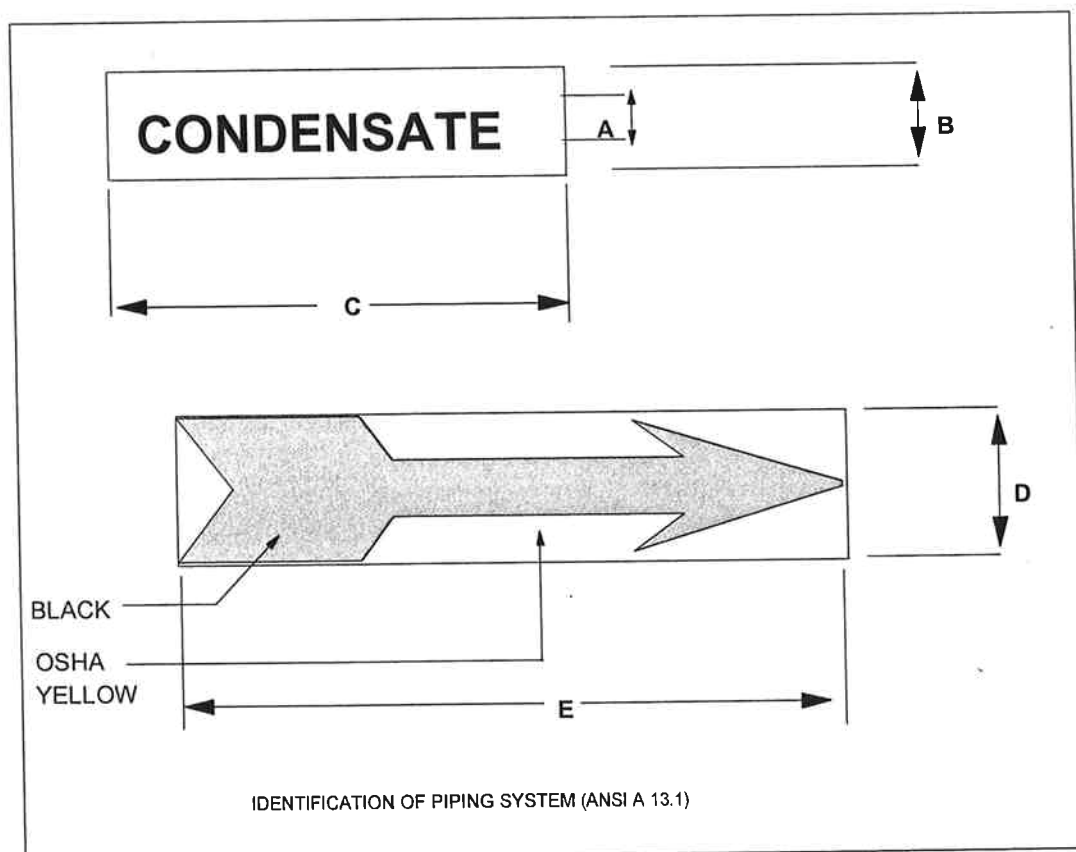
- Colour of the square is as described in section 10.2.

APPENDIX 5 - PIPING IDENTIFICATION SYSTEM

Units : Inches

TYPE	PIPE O.D.	IDENTIFICATION LEGEND			FLOW DIRECTION ARROW	
		A	B	C	D	E
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

PIPING IDENTIFICATION SYSTEM



PIPING COLOUR IDENTIFICATION LEGEND

UTILITY & GENERAL

air, instrument	inst. air	OSHA blue/white	/00-E-55
air, utility	utility air	OSHA blue/white	/00-E-55
gas, instrument	inst. gas	Black/OSHA Yellow	00-E-53/
gas, utility	utility gas	Black/OSHA Yellow	00-E-53/
hydraulic	hydraulic	Black/OSHA Yellow	00-E-53/

UTILITY GAS & FUEL

BLANKET gas	blanket gas	Black/OSHA Yellow	00-E-53/
diesel fuel	diesel fuel	Black/OSHA Yellow	00-E-53/
aviation fuel	aviation fuel	Black/OSHA Yellow	00-E-53/
fuel gas	fuel gas	Black/OSHA Yellow	00-E-53/
nitrogen	nitrogen	OSHA blue/white	/00-E-55

UTILITY OIL

lube oil	lube oil	Black/OSHA Yellow	00-E-53/
seal oil	seal oil	Black/OSHA Yellow	00-E-53/
hot oil	hot oil	Black/OSHA Yellow	00-E-53/

CAUSTIC & CHEMICAL

chemical	chemical	Black/OSHA Yellow	00-E-53/
glycol	glycol	Black/OSHA Yellow	00-E-53/
caustic	caustic	Black/OSHA Yellow	00-E-53/
chlorine	chlorine	Black/OSHA Yellow	00-E-53/

GENERAL

treated water	treated H ₂ O	OSHA GREEN/WHITE	/00-E-55
black water	black H ₂ O	OSHA GREEN/WHITE	/00-E-55
grey water	grey H ₂ O	OSHA GREEN/WHITE	/00-E-55
hot water	hot H ₂ O	Black/OSHA Yellow	00-E-53/

OTHERS

to be determined by principal

APPENDIX 7

Coating Systems Testing Requirements

Coating Systems Testing Requirements									
Coating System No.	Salt Spray	Cyclic Salt Fog/UV Exposure	Adhesion	Impact	Abrasion	Water Immersion	Cathodic Dis-bonding	Accelerated Weathering	Heat Resistance
External Coating Systems									
1A									
1B									
1C									
2A									
2B									
2C									
3A									
3B									
4A									
4B									
5A(1)									
5A(2)									
5B(1)									
5B(2)									
6A									
7A(1)									
7A(2)									
7A(3)									
8B									
11									

Note :
Cyclic Salt Fog/UV Exposure test may be carried out in addition to the Salt Spray and Accelerated Weathering tests whenever considered necessary.

Adhesion test shall be carried out using the hydraulic adhesion/tensile tester.

Abrasion test is mandatory for coating systems which will be exposed to abrasion, wear and tear.

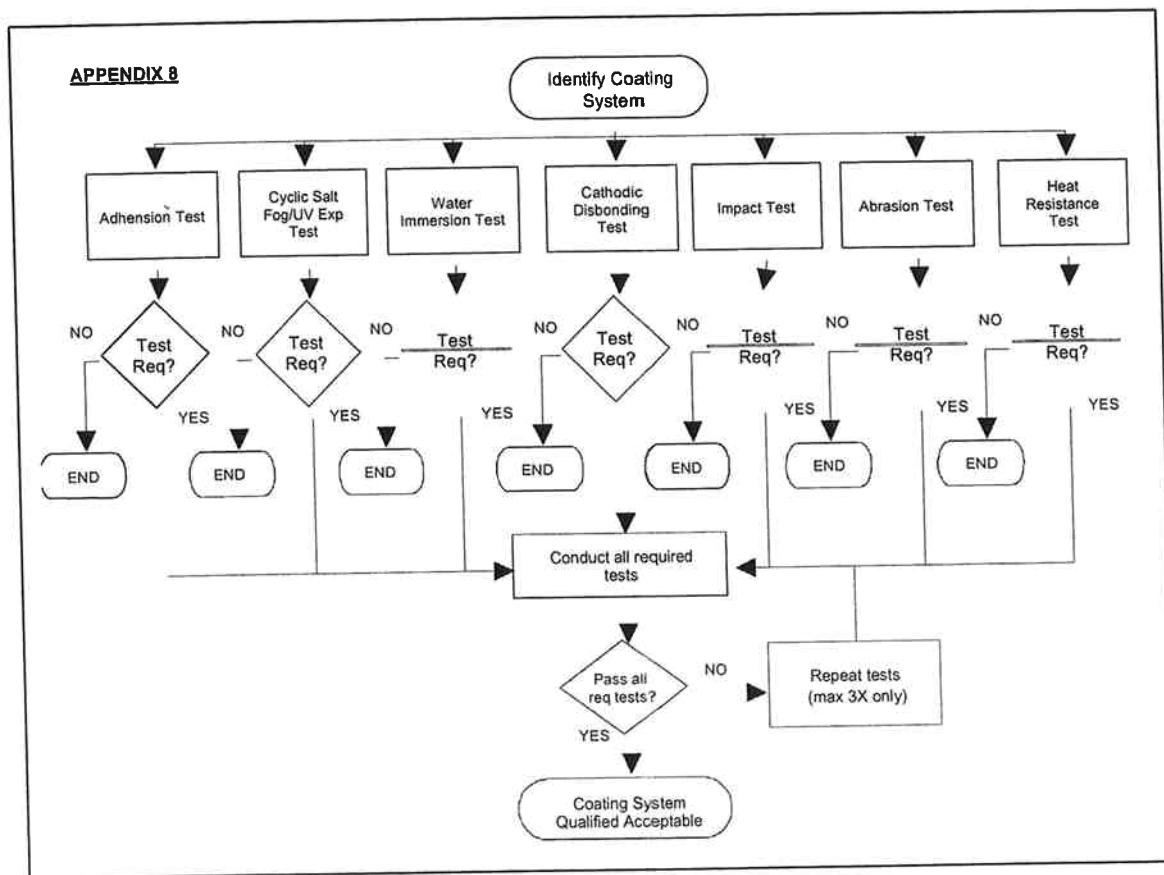
APPENDIX 7

Coating Systems Testing Requirements

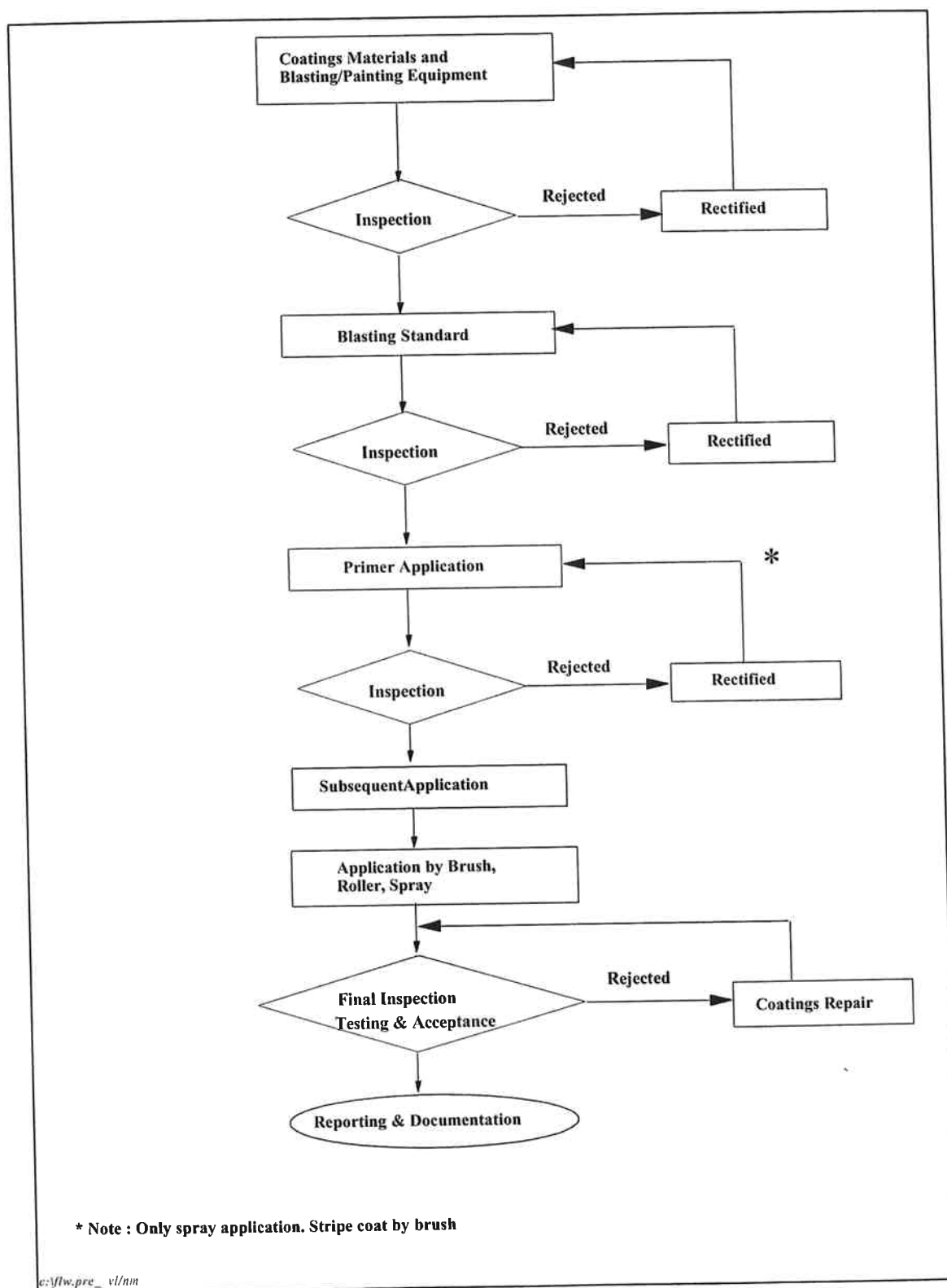
Coating Systems Testing Requirements									
Coating System No.	Salt Spray	Cyclic Salt Fog/UV Exposure	Adhesion	Impact	Abrasion	Water Immersion	Cathodic Dis-bonding	Accelerated Weathering	Heat Resistance
External Coating Systems									
13A									
14A(1)									
14A(2)									
14A(3)									
15A									
16A									
16B									
16C									
17A									
18A									
19A									
19B									
19C									
19D									
20A									
21A									
21B									
22A									
22B									
22C									

Note :
 Adhesion test shall be carried out using the hydraulic adhesion/tensile tester.
 Abrasion test is mandatory for coating systems which will be exposed to abrasion, wear and tear.

APPENDIX 8 - COATING SYSTEM APPROVAL PROCESS FLOW



APPENDIX 9 – FLOW CHART FOR INSPECTION OF BLASTING AND PAINTING ACTIVITIES



APPENDIX 10



PETRONAS CORPORATE POLICY STATEMENT ON HEALTH, SAFETY AND ENVIRONMENT

PETRONAS' Corporate Policy is to strive for excellence in all its activities including health, safety and environmental matters.

PETRONAS is committed to give priority to Health, Safety and Environment, wherever PETRONAS operates and shall endeavour to take every reasonable and practicable step to prevent and eliminate the risk of injuries, health hazards and damage to properties. PETRONAS shall also take proactive steps towards the conservation and preservation of the environment.

To achieve these objectives, PETRONAS shall ensure that the facilities it designs, builds and operates, the products it manufactures and the service it provides are in accordance with appropriate legal requirements, industry standards and best practices.

PETRONAS shall provide the necessary resources, organisation, system and training and shall communicate with employees, contractors, customers, suppliers and the public with regard to appropriate matters on health, safety and environment.

PETRONAS shall also ensure that contingency plans are in place and maintained to deal with emergencies and shall periodically review the health, safety and environment management system and practices to ensure their continual improvement.

PETRONAS expects all its employees and contractors to strictly adhere to this policy at all times.

DATO' MOHD HASSAN MARICAN
President
PETRONAS

24 February 1997

APPENDIX 11 - COLOUR SCHEME FOR ONSHORE/OFFSHORE INSTALLATION & EQUIPMENT

No.	STRUCTURES /ITEMS	COLOUR	BS 4800 CODE
1.	<u>Splash Zone/Spider Deck</u> Offshore structural members steel below castellation point (shim connection splash zone substructures), spider deck and boat landing	Yellow	1c E 53
2.	<u>Cellar Deck up to Main Deck incl. Bridge Structure</u> Structural members, from cellar deck up to the main deck, castellation point outwards, beams, girders, underside of drip pan, pipe support & cable	Yellow	1c E 53
3.	Risers	Yellow	1c E 53
4.	Footway & stairway supports	Yellow	1c E 53
5.	Grating panel (maintenance only)	Yellow	1c E 53
6.	Handrails	Alert Orange	-
7.	Pressure Vessels, Columns, Heat Exchangers	White	cc E 55
8.	Wellheads	White	cc E 55
9.	Pipeworks except valves bodies, manifolds and firewater lines <i>*refer to Appendix 6 for Piping Colour Identification</i>	White	cc E 55
1c.	Storage Tank	White	cc E 55
11.	Chemical Tank	White With Black stripe	cc E 55 cc E 53
12.	Instrument Control Panel, Instrument & Lighting stand	White	cc E 55
13.	<u>Module (including Living Quarters)</u> ↻ Interior Walls and Ceiling ↻ Exterior Walls ↻ Production Shed & Equipment Store	White White White	cc E 55 cc E 55 cc E 55
14.	<u>Helideck</u> a) Structure and underside helideck, footway & Stairway supports, ladders, instrument & lighting stand and cable tray b) Helideck landing	White Holy Green (BS 4800 : 14-C-39)	cc E 55 12 E 53
15.	Deck Top of Living Quarters	Forest Green	12 E 53
16.	Firewater lines	OSHA Red	-
17.	Process/Utility piping, temp > > 110°C	Aluminium	-
18.	Conductor pipes	Yellow (10-E-53)	cc E 53
19.	Inside drip pan including pipeworks	Black	cc E 53
20.	Chequer plates	Yellow (10-E-53)	cc E 53
21.	Jib crane and gantry crane booms and monorail	Alternate Black & Yellow	cc E 53
22.	Pumps, motors, generators and other moving equipment	Mid green	14 E 53

APPENDIX 12 - SPECIFICATION FOR FLUOROCARBON COATING OF BOLT AND NUTS

1.0 SCOPE

This specification establishes the minimum requirements for fluorocarbon coated bolting for use on onshore and offshore oil and gas facilities.

2.0 GENERAL

- 2.1 Bolts shall be ASTM A-193-B7 studs with ASTM A-192-2H Heavy Hex Nut. All bolting shall be fluorocarbon coated unless otherwise specified. Coating shall be based on the PTFE (Poly Tetra Fluoro Ethylene) and shall be of the bake cure type.
- 2.2 Special allowances may be determined as specified in ANSI B1.13M and ASTM F871M Annex A1 for bolts thread to be manufactured to special limits and tolerances in order to accommodate the coating thickness. This is to avoid binding because the modification may significantly reduce the thread shear or stripping strength.
- 2.3 Materials used for cleaning shall have no damaging effects on the base metal that can result in pits, inter granular attack, stress corrosion, cracking or hydrogen embrittlement.
- 2.4 Surface contaminants that must be removed are handling soils, environmental matter, drawing oils or compounds, polishing abrasives and binders, rust preventative, or protective coatings. Mechanical and/or chemical treatments shall be used to produce a surface that is satisfactory for subsequent plating/deposition and finish coating.
- 2.5 During plating/deposition process, thorough rinsing is required between cleaners, activators and deposition solutions to prevent contamination of the solutions by drag-in. Agitate rinses and provide spray or counter flow cascading, or both, to conserve the use of water. Demonized water is recommended for the final rinse. The appearance of water breaks followed a rinse indicates incomplete removal of soil and insufficient cleaning. If a water break occurs, pretreatment process shall be repeated.
- 2.6 All pretreatment and plating/deposition process steps shall be carried out with solutions that are constantly maintained in good working condition by control of composition and contaminant, and used under

APPENDIX 12 - SPECIFICATION FOR FLUOROCARBON COATING OF BOLT AND NUTS

conditions of time, temperature and current density specified to meet the requirements of the work being processed.

- 2.7 Only thinner, solvent and cleaner recommended by the coating manufacturer shall be used.
- 2.8 All coated nuts of a particular size shall be able to be hand threaded onto the full thread length of all coated bolts of that similar size without any damage to the coating.
- 2.9 Bolting components with ultimate tensile strength greater than 1650 MP_a (hardness greater than 50 HRC) shall not be plated or coated.
- 2.10 Bolting components with ultimate tensile strength equal or greater than 1050 MP_a (hardness of 35 HRC or more) shall be heat treated at 170+/- 15°C for 5 hours or more for stress relief before cleaning and plating.
- 2.11 Heat treatment shall not reduce the surface hardness of the bolting component material.
- 2.12 Bolting components shall not be heated above a temperature that is 50°C below the tempering temperature or above 320°C, or whichever minimum. The duration for relief time shall apply from when the parts have reached the minimum temperature.
- 2.13 Coating system must be capable of remaining stable at max. 250°C.

3.0 COATING SYSTEM QUALIFICATION REQUIREMENTS

- 3.1 CONTRACTOR shall conduct Salt Spray qualification performance testing per table 1. The test need only be performed to qualify for supply to COMPANY and not for each batch or lot of bolts supplied. The testing shall be carried out at a COMPANY approved laboratory.

APPENDIX 12 - SPECIFICATION FOR FLUOROCARBON COATING OF BOLT AND NUTS

Table 1 - Salt Spray Test

NO	TYPE OF TEST	TEST METHOD	ACCEPTANCE CRITERIA	FREQUENCY
1.	Salt Spray Test	ASTM B117	Minimum Test 2000 hours Bolts/nuts shall be functional (i.e. able to be operated by hand)	To qualify for supply to COMPANY

3.2 The following tests shall be performed in accordance with table 2, para 4.1 prior to conducting Salt Spray Test.

- (i) Visual
- (ii) Dry Film Thickness
- (iii) Curing
- (iv) Adhesion
- (v) Coating Hardness

3.3 The following test reports shall be submitted to COMPANY for review and approval of the coating system :

- (i) Visual Examination test results
- (ii) Dry Film Thickness test results (plating/deposition and total DFT)
- (iii) Curing Test results
- (iv) Adhesion test result
- (v) Coating hardness Test results
- (vi) Salt Spray Test report

3.4 If changes have been made to the manufacturing process and procedures, CONTRACTOR(s) shall resubmit the above documents for review/approval by COMPANY.

APPENDIX 12 - SPECIFICATION FOR FLUOROCARBON COATING OF BOLT AND NUTS

4.0 INSPECTION AND TESTING

4.1 The samples selected for each batch shall be subjected to the following minimum test requirements as per table 2.

Table 2. Type of tests for coating of bolt and nuts.

NO.	TYPE OF TEST	TEST METHOD	ACCEPTANCE CRITERIA	FREQUENCY
1	Visual	N.A.	Free of surface defects such as burrs, pits, inclusion, scale, crevices, burns, corrosion product and oxides	100%
2	Dry Film Thickness	ASTM B 299 Measurement at flat end	Total DFT 32-50 micron	Sampling as per ASTM B 602, Level I, highest quality level
		ASTM B 287 Destructive measuring of coating thickness	Total DFT 32-50 micron	One sample per order (at COMPANY Discretion)
4	Curing	Cotton swab soaked in methyl-Ethyl-ketone (MEK) and applied to all surface	Non-conforming if there is any indication of discoloration	Sampling as per ASTM B 602, Level I, highest quality level
5	Adhesion	ASTM D 3359 Method B (Cross Cut)	ASTM D 3359 Category 3A	Sampling as per ASTM B 602, Level I, highest quality level

APPENDIX 12 - SPECIFICATION FOR FLUOROCARBON COATING OF BOLT AND NUTS

6	Coating Hardness	ASTM D 3363	Para 7, ASTM D 3368	Sampling as per ASTM B 602, Level I, highest quality level.
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- 4.2 The total coating thickness on the bolting components shall not exceed the specified or agreed upon maximum thickness on significant surface and/or flat surface.

5.0 COATING SYSTEMS FOR BOLTING COMPONENTS

- 5.1 The coating system for the bolting components shall be electrode posited phosphate with Fluoropolymer Coating as its protective coating.

- 5.2 Type of plating and coating :

5.2.1 Phosphate plating :

The bolting components shall be phosphate treated in accordance with BS 3187 /ISO 7717 with the appropriate recommendation(s) from the coating supplier. CONTRACTOR(s) shall ensure that the phosphate conversion coating is appropriately prepared to receive the finish coating.

5.2.2 Fluorocarbon Coating :

The finish coating shall be Xylan 1000 series manufactured by Whitford Corporation, or fluoropolymer coatings manufactured by Dupont, for the purpose of coating bolting components. CONTRACTOR(s) shall specify the actual type used in the submission as per para 2.6. Alternative type may be selected only if its chemical and environmental resistance, and performance characteristics are comparable to this specification requirements. However, prior written COMPANY approval shall be obtained.

APPENDIX 12 - SPECIFICATION FOR FLUOROCARBON COATING OF BOLT AND NUTS

5.3 The plating shall be carried out by Barrel method per ASTM B-766. An alternative method or type of plating may be used with prior approval from COMPANY.

5.4 Surface preparation of the base metal before plating shall confirm to ASTM B-222.

5.5 Baking of fluorocarbon coating for full curing shall be carried out in strict compliance to the material manufacturer's latest instructions and equipment requirement. The temperature range and duration of baking shall be specified during initial submission as per para. 2.6 and is to be considered an essential variable, subject to COMPANY approval.

6.0 PACKING

6.1 The coated bolts and nuts shall be properly packed and wrapped to avoid damage during handling and storage. Plastic netting for protecting each item shall be used if specified by COMPANY.

6.2 Any coated bolts, nuts and washers found to be defective or damaged and not in compliance to the requirements of this specification upon receipt shall be rejected and replaced by CONTRACTOR.

7.0 CERTIFICATE

7.1 All bolts and nuts supplied to this specification shall be accompanied with complete test certificates for all testing required in this specification.

7.2 Each test certificate shall be signed by an authorized company officer with the name legibly displayed.

7.3 Certificate shall be issued with the following details :

(i) Bolts and nuts Material Certificate

APPENDIX 12 - SPECIFICATION FOR FLUOROCARBON COATING OF BOLT AND NUTS

- (ii) Batch Number
- (iii) Date
- (iv) Number, Type and Size
- (v) Testing Results

7.4 Test reports shall be submitted for each batch of bolts and nuts delivered to COMPANY and, at a minimum, consist of the following :

- (i) Visual Examination test results
- (ii) Dry Film Thickness test results (plating/deposition and total DFT)
- (iii) Curing Test results
- (iv) Adhesion test results
- (v) Pre-coating data including heat treatment report.
- (vi) Coating materials certificate

7.5 All coated bolts shall be stamped with the manufacturer's company symbol/trademark and Grade. Unmarked bolt and nuts shall be rejected.