PETROBRAS	TECHNICAL SPECIFICATION	Nº: I-ET-3010.00-1200-956-P4X-002	
	CLIENT:		SHEET: 1 de 101
	JOB:		
	AREA:		
SRGE	TÍTLE: GENERAL PAINTING		SRGE/ESUP
			INTERNAL

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DATE	MAR/25/21	OCT/05/21	OCT/30/22	DEC/12/22	APR/15/23	JUN/14/24
EXECUTION	CJH4	CJH4	CJH4	CJH4	CJH4	CJH4
CHECK	SXED	SXED	SXED	SXED	SXED	SXED
APPROVAL	U32N	CJV5	U32N	U32N	U32N	CJX4

SUMMARY

QUICK GUIDE – TABLES

QUICK GUIDE – COATING SYSTEMS

1. SCOPE

1.1. This specification contains requirements for material selection; quality control; contractor documentation requirements, and warranty of protective coating to be applied for Petrobras offshore units and facilities. It covers organic liquid coating, elastomeric coatings, fusion bonded epoxy (FBE) and fluoropolymer internal coating for piping, electrostatic powder coating and hot dip galvanizing.

1.2. The objective of this technical specification is to obtain a coating system that meets the very high durability range as defined in ISO 12944-1, which means an expected service life until the first major maintenance painting of 25 years (less than 10% of coated area with Ri3 ISO 4628-3 grade). For coating material selection, the desired durability shall consider laboratory tests, painting formulation and commercial grade and track record.

2. NORMATIVE REFERENCES

The following referenced documents contain text which fully or in parts is part of the requirements of this technical specification and are indispensable for the application of this document.

2.1. CODES AND STANDARDS

API RP 5L2 - Recommended Practice for Internal Coating of Line Pipe for Non-Corrosive Gas Transmission Service.

API SPEC 6A - - Specification for Wellhead and Tree Equipment

ASTM A123 -Standard Specification for zinc (hot-dip galvanized) coatings on iron and steel products.

ASTM A153 - Standard Specification for zinc coating (hot-dip) on iron and steel hardware.

ASTM A792 - Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process

ASTM D2247 Standard Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity

ASTM D3418 - Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry.

ASTM D4060 - Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.

ASTM D4285 - Standard test method for indicating oil or water in compressed air.

ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.

ASTM D4940 - Standard Test method for conductimetric analysis of water soluble ionic contamination of blasting cleaning abrasives.

ASTM D522 - Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings

ASTM D570 - Standard Test Method for Water Absorption of Plastics

ASTM D638 - Standard Test Method for Tensile Properties of Plastics

ASTM D6943 - Standard Practice for Immersion Testing of Industrial Protective Coatings and Linings

ASTM F22 - Standard Test Method for Hydrophobic Surface Films by the Water-Break Test.

AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination

AWS C2.25/C2.25M - Specification for Thermal Spray Feedstock - Wire and Rods

CSA Z245.20 - Plant-applied external coatings for steel pipe

DNVGL-RP-B401 - Cathodic protection design

EN 10169 - Continuously organic coated (coil coated) steel flat products - Technical delivery conditions.

IMO RESOLUTION MSC.215(82) -Performance Standard for Protective Coatings for Dedicated Seawater Ballast Tanks in All Types of Ships and Double-Side Skin Spaces of Bulk Carriers.

IMO RESOLUTION MSC.288(87) Performance Standard for Protective Coatings for Cargo Oil Tanks of Crude Oil Tankers

ISO 1461 - Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods.

ISO 21809-2 - Petroleum and natural gas industries — External coatings for buried or submerged pipelines used in pipeline transportation systems — Part 2: Single layer fusion-bonded epoxy coatings.

ISO 2812-1 Paints and varnishes - Determination of resistance to liquids - Part 1: Immersion in liquids other than water

ISO 3233-parts 1 to 3- Paints and varnishes - Determination of the percentage volume of non-volatile matter

ISO 4624 - Paints and varnishes - Pull-off test for adhesion.

ISO 4628: Part 1 to 6 - Paints and Varnishes - Evaluation of Degradation of Coatings - Designation of quantity and size of defects, and of intensity of uniform changes in appearance.

ISO 6272-1 - Paints and varnishes - Rapid-deformation (impact resistance) tests — Part 1: Falling-weight test, large-area indenter.

ISO 8501: Part 1 to 3 - Preparation of steel substrates before application of paints and related products. - Visual assessment of surface cleanliness.

ISO 8502: Parts 2 to 6; 9; 11 - Preparation of steel substrates before application of paints and related products. - Test for the assessment of surface cleanliness.

ISO 8503: Parts 4 and 5 - Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates.

ISO 11124: Part 1 to 4 - Preparation of steel substrates before application of paints and related products - Specifications for metallic blast-cleaning abrasives.

ISO 11125: Part 1 to 7 - Preparation of steel substrates before application of paints and related products. Test methods for metallic blast-cleaning abrasives.

ISO 11126: Part 1 to 8 - Preparation of steel substrates before application of paints and related products. Specifications for non-metallic blast-cleaning abrasives.

ISO 11127: Part 1 to 7 - Preparation of steel substrates before application of paints and related products. Test methods for non-metallic blast-cleaning abrasives.

ISO 12944: Parts 1; 2, 3 and 9 - Paints and varnishes - Corrosion protection of steel structures by protective paint systems.

ISO 14919 - Thermal spraying - Wires, rods and cords for flame and arc spraying - Classification - Technical supply conditions

ISO 17025 - General requirements for the competence of testing and calibration laboratories.

ISO 17652-2 - Welding - Test for Shop Primers in Relation to Welding and Allied Processes - Part 2: Welding Properties of Shop Primers.

ISO 19277 - Petroleum, petrochemical and natural gas industries - Qualification testing and acceptance criteria for protective coating systems under insulation

ISO 19840- Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Measurement of, and acceptance criteria for, the thickness of dry films on rough surfaces.

ISO 28199 -1 - Paints and Varnishes - Evaluation of Properties of coating systems related to the application process.

ISO 29601 - Paints and varnishes — Corrosion protection by protective paint systems —Assessment of porosity in a dry film

NACE SP0188 - Discontinuity (holiday) testing of new protective coatings on conductive substrates.

NACE SP0287 - Field measurement of surface profile of abrasive blast-cleaned steel surfaces using a replica tape.

NACE TM 0104 - Offshore Platform Ballast Water Tank Coating System Evaluation.

NACE TM0185 - Evaluation of Internal Plastic Coatings for Corrosion Control of Tubular Goods by Autoclave Testing - Item No. 21217

NACE TM 0404 - Offshore Platform Atmospheric and Splash Zone New Construction Coating System Evaluation.

NACE WJ-2 - Waterjet Cleaning of Metals – Very Thorough Cleaning (WJ-2)

NHO 11 - Norma de Higiene Ocupacional - Avaliação dos níveis de iluminamento em ambientes internos de trabalho

NSF 61 - Drinking water system components - Health effects.

SSPC SP 1 - Solvent cleaning.

SSPC SP 7 - Brush-off Blast Cleaning - NACE No. 4

SSPC SP 11 - Power Tool Cleaning to Bare Metal.

SSPC SP 12 - Surface Preparation and Cleaning of Cleaning of Metals by Waterjetting Prior to Recoating - NACE NO. 5

SSPC VIS 4 - Guide and Reference Photographs for Steel Surfaces Prepared by Waterjetting - NACE VIS 7;

SSPC-TR 3/NACE 6A192 - Dehumidification and temperature control during surface preparation, application, and curing for coatings/linings of steel tanks, vessels and other enclosed areas.

2.2. GOVERNAMENTAL REGULATION

Regulatory Standard are mandatory and shall prevail, if more stringent, over the requirements of this specification and other references herein.

NR-26 Brazilian Regulatory Standard - Safety Signing

NR-37 Brazilian Regulatory Standard - Safety and Health in Petroleum Platforms

NORMAM-401/DPC Maritime Authority Standards for the Prevention of Environmental Pollution from Vessels and Platforms.

2.3. DESIGN DOCUMENTS

I-ET-3010.00-1200-956-P4X-003	THERMAL SPRAY COATING APPLICATION OF ALUMINUM
I-ET-3010.00-1200-940-P4X-002	GENERAL TECHNICAL TERMS
I-ET-3010.00-1200-970-P4X-003	REQUIREMENTS FOR PERSONNEL QUALIFICATION AND CERTIFICATION
I-ET-3010.00-5267-750-P4X-001	TECHNICAL SPECIFICATION FOR CATHODIC PROTECTION
I-ET-3010.00-5267-750-P4X-002	TECHNICAL SPECIFICATION FOR GALVANIC ANODES
I-ET-3010.00-5400-433-P4X-001	PASSIVE FIRE PROTECTION
I-ET-3010.00-1000-950-P4X-001	MARINE BIOFOULING
I-ET-3010.00-1200-217-P4X-001	SUPPLEMENTARY SPECIFICATION TO ISO18797-1
I-ET-3010.00-1200-251-P4X-001	REQUIRIMENTS FOR BOLTING MATERIALS
DR-ENGP-I-1.15	COLOR CODING

2.4. PROJECT SPECIFICATION TO BE SUPPLIED BY BUYER

[FPSO NAME]

[I-DE-HULL STRUCTURAL TANKS TEMPERATURES]

3. DEFINITIONS AND ABBREVIATIONS

3.1. DEFINITIONS

3.1.1. In addition to the term and definitions established in the latest revision I-ET-3010.00-1200-940-P4X-002 - GENERAL TECHNICAL TERMS, the terms and definitions of referenced codes and standards area applicable. Also, the following terms apply:

Paint System: For the purpose of this technical specification is the same of coating system.

3.2. ABBREVIATIONS

AC – Air Conditioning

C&A: Construction and Assembly

CRA: Corrosion Resistance Alloy.

CS: Coating System

CUI: Corrosion under insulation.

CP: Cathodic Protection

DFT: Dry film thickness.

FRP: Fiber Reinforced Polymer

FBE: Fusion-Bond Epoxy.

HDG: Hot dip galvanizing.

IAF: International Accreditation Forum

INMETRO: Brazilian Institute for Standardization and Industrial Quality.

MSDS: Material safety data sheet.

N/A: Not applicable

PDS: Product data sheet.

PQR: Weld procedure qualification record

QCP: Quality control plan.

SS: Stainless steel.

4. GENERAL REQUIREMENTS

4.1. CLASSIFICATION OF ENVIRONMENTS

4.1.1. The environment classification is according to ISO 12944-Part 2 and five environmental class are considered for Petrobras offshore units:

a) Atmospheric zone: structures situated above the water.

b) Ventilated Rooms: structures and equipment inside closed areas without humidity and temperature control.

c) Controlled Environment Rooms: and equipment inside closed areas with humidity and temperature control (HVAC System).

d) Splash zone: structures that is alternatively above and below the water line. For fixed offshore units this means the region alternatively wet and dry due to tide and waves. For mobile offshore units this means the boottop region.

e) Immersed zone: structures that are underwater and not subjected to wet and dry alternation.

4.1.2. The inferior and superior limit of splash zone region shall be determined in accordance with [FPSO NAME].

4.1.3. For guidance, Table 1 correlates Petrobras offshore unit environmental classification with correspondent corrosivity category.

Table 1 - Environmental Classification

Region	Corrosivity Category
Atmospheric zone	CX
Ventilated Room	C5
Controlled Environment Rooms	C4
Splash zone	Im2/ Im4/CX
Immersed zone	Im2 / Im4

4.2. DESIGN AND PLANING

4.2.1. If coated structures, equipment, piping or items design and planning do not comply with ISO12944-3 recommendations mitigating actions need to be agreed upon.

4.2.2. Deck area may receive a specific temporary coating resistant to impact and abrasion, with objective to retain the surface preparation profile and avoid premature corrosion during construction time.

4.3. PRE-FABRICATION PRIMER, SHOP PRIMER AND HOLDING PRIMER

4.3.1. Shop primer, holding primer and pre-fabrication primer shall be completely removed prior to the application of the coating systems.

4.3.1.1. The pre-fabrication primer may be incorporated to the paint systems if surface preparation followed the requirements of this specification for Coating System application and the Coating Manufacturer confirms the compatible with the subsequent painting scheme, suitability for service/environment and integrity of primer. This is not applicable for tanks, internal coating and immersion areas.

4.3.1.2. The integrity of pre-fabrication primer shall be evaluated by visual inspection and a pull-off test. A minimum value of 5MPa is required.

4.3.1.3. For Hull and Module structure, the primary surface preparation and pre-fabrication primer shall be selected and have thickness with sufficient durability until secondary surface treatment starts. For hull structural tanks non-coated areas, the shop primer durability shall cover the hull construction period.

4.3.2. Weldable pre-fabrication primer may be used if they are in accordance with ISO 17652-2, and applicable requirements of classification society. The weld PQR shall consider the presence of pre-fabrication primer.

4.4. UNCOATED SURFACES

4.4.1. The following items, when not submerged in salty water, shall not be coated for corrosion protection unless otherwise mentioned in the contract.

a) Non-insulated austenitic stainless steel with maximum operating temperature below 50°C

b) Duplex stainless steel with maximum operating temperature below 80°C.

c) Superduplex stainless steel with maximum operating temperature below 90°C.

d) Non-ferrous metal surfaces (e.g., brass, copper, titanium). This is not applicable to aluminum.

e) Inconel surfaces.

f) Surfaces which shall not be coated: nameplates, valve stems, shafts, mechanically finished surfaces, gauges, windows and all other regions that the paint affect the component or equipment use according to BUYER.

g) Flange faces where contact with gasket occurs, unless specified otherwise (see item 7.5.18).

h) Hub connector seal ring contact surface.

i) Plastic coated surfaces.

j) Tubbing.

k) Pigmented FRP

4.4.2. The active surface of areas of cathodic protection (CP) anodes does shall not be coated in any case.

4.4.3. The exception is in case of color requirement as per DR-ENGP-I-1.15 – COLOR CODING.

4.4.4. The internal surface of piping and equipment shall only be coated when determined in the material specification.

4.5. PRESERVATION OF UNCOATED SUFACES

4.5.1. Tubing, fittings, cable trays, piping, supports, junction boxes, equipment, and any other parts and/or materials, even in stainless steel, duplex and superduplex, copper-nickel, special stainless alloys and inconel, shall be protected in order to avoid contamination during storage, construction and commissioning phases.

4.5.2. A specific procedure shall be submitted for BUYER's approval detailing the products to be used.

4.5.3. External passivation of all stainless steel, duplex and superduplex items shall be performed towards the end of onshore phase construction activities at integration yard. In case of iron contamination, a pickling shall precede the passivation. Tubing iron contamination or any deposit/contamination that may cause a crevice is not allowed and shall be removed before sail away.

5. COATING SYSTEMS PRE-QUALIFICATION

5.1. GENERAL REQUIREMENTS OF PRE-QUALIFICATION

5.1.1. Each coating system has a pre-qualification protocol which validation depends on one or more of the following requirements:

a) Laboratory Testing: performance or physicochemical properties analysis and validation that may be required by a coating system or isolated coating material.

b) Track Record: Documented past performance of a coating system in specific environments.

5.1.2. Coating manufacturers are responsible for pre-qualification of their coating systems. Laboratory tests required by pre-qualification protocol shall be carried out by independent laboratory in compliance with ISO 17025 or equivalent and certified by International Accreditation Forum (IAF) or INMETRO.

5.1.3. Each coating material forming a coating system shall be produced by the same coating manufacturer.

5.1.4. Whenever a track record required is mentioned, COATING MANUFACTURER shall provide proven track record of performance in similar environment at Oil and Gas industry over 5 years.

5.1.5. The Table 8 presents the pre-qualification protocol applicable to each individual coating system detailed at ANNEX A.

5.1.6. A change in composition of individual paint in the coating system, as established through fingerprinting and batch testing require re-qualification.

5.1.7. The approved topcoat in a pre-qualified coating system, may substitute another pre-qualified topcoat, provided the intermediate coating is the same and the film-thickness of the topcoats are equal.

5.1.8. Successful pre-qualification test with DFT lower than those required by this specification are considered accepted for material selection purpose, but the minimum dry film thickness stated at each coating system at ANNEX A shall be followed.

5.1.9. In case of pre-qualification tests with DFT higher than 10% of those required by this specification, the DFT used in the pre-qualification test shall be the one established as a minimum in coating system at detailed design.

5.1.10. Additional testing may not be required for a coating system on stainless steel, if the proposed coating system on carbon steel panels has been approved by the BUYER.

5.1.11. The BUYER may waive performance of existing coating systems based on relevant, documented testing or field experience.

5.1.11.1. This is the case for pre-qualification executed based in a superseded standard like ISO20940 or NORSOK M-501 rev.5, where the pre-qualification shall be supplemented by a track record and are subjected to BUYER evaluation.

5.1.11.2. A coating system that does not strictly follow this technical specification testing protocol

(testing method, acceptance criteria, and testing protocol) may have its dossier send to BUYER analysis as a proposed Coating System. This dossier shall be issued by coating manufacturer and include the coating system track record.

5.1.12. All coating systems specification with its pre-qualification testing reports documentation shall be submitted for BUYER analysis. The document shall include at least:

a) Material Safety Data Sheet.

b) Information data required by item 5.4 of ISO 12944-9.

c) Qualification tests reports.

5.2. LIQUID COATING SYSTEMS PRE-QUALIFICATION

5.2.1. Table 2 lists performance tests and acceptance criteria applicable for coatings systems based on liquid paints. The specific performance tests applicable for each individual coating system are presented in table 8 and detailed in annex A.

5.2.1.1. Edge retention propriety is an optional test to permit the use of edge preparation type 2c. In that case, the coating system shall be previously evaluated in accordance with NACE TM 404.

Table 2- Performance tests requirements for liquid coatings systems

Performance test		Verification method[1]	Acceptance criteria
Nº	Description		
1	Fingerprinting	ISO 12944-9 Annex C	ISO 12944-9 Annex C
2	Cyclic ageing test	ISO 12944-9 Clause 9	ISO 12944-9 Clause 9 Chalking to ISO 4628-6, maximum rating 2. Pull-off test to ISO 4624, minimum 5,0 MPa and maximum 50% reduction from value measured before ageing.
3	Seawater immersion test	ISO 12944-9 Clause 9	ISO 12944-9 Clause 9
4	Cathodic disbonding test	ISO 12944-9 Clause 9	ISO 12944-9 Clause 9
5	Abrasion Test	ASTM D4060 (mg/1000 cycles), CS-17, 1kg.)	Max 65 mg
6	Impact test	ISO 6272-1	3J
7	Friction coefficient	MIL-PRF-24667C, Note 1	0.75
8	Corrosion under insulation testing	ISO 19277 Note 1Tests for CUI-2 and CUI-3 including optional vertical pipe test.	ISO 19277.
9	Flexibility	NACE TM0404	>1% at the lowest service temperature
10	Hot/wet cycling	NACE TM0104	<3.5 mm (0.14 in) No blistering /rusting /cracking /flaking away from the scribe and edge
11	IMO RESOLUTION MSC.215	Test on simulated ballast tank conditions. Condensation chamber test	According to Appendix 1 of IMO RESOLUTION MSC.215 According to Appendix 2 of IMO RESOLUTION MSC.215
12	IMO RESOLUTION MSC.288	Gas-Tight Cabinet test Immersion Test	According to Appendix 1 of IMO RESOLUTION MSC.288 According to Appendix 2 of IMO RESOLUTION MSC.288

Table 2 Performance tests requirements for liquid coatings systems (cont.)

Performance test Nº	Performance test Description	Verification method[1]	Acceptance criteria
13	Atlas cell @ 60 ° C	ASTM D6943, Note 2	No blisters, cracks and rust spots after 2000h. Pull-off test to ISO 4624, minimum 5,0 MPa and maximum 50% reduction from value measured before ageing.
14	Adhesion (Pull-Off Test), MPa	ASTM D 4541 or ISO 4624 Method D – Equipment types IV or Method E – Equipment Type V (hydraulic automatic)	Initial adhesion >15 MPa Failure type: -/ Y, Y or Y/Z. Adhesion after immersion test: Failure type A/B.
15	Cathodic Disbonding G8	ASTM G 8 30 days immersion in a saline solution subjected to -1.57 VSCE	DEC 10 mm
16	Chemical resistance	ISO 2812-1. Resistance to immersion in 40% H_2SO_4; distilled water at 40°C; NaOH at 10% and xylene	80% of coupon area immersed. No blisters, cracks and rust spots after 2000h
17	Atlas cell @ 80 ° C	ASTM D6943; Note 2	No blisters, cracks and rust spots after 2000h. Pull-off test to ISO 4624, minimum 5,0 MPa and maximum 50% reduction from value measured before ageing.
18	Water immersion	ISO 2812-1 Resistance to immersion in distilled water at 40°C;	80% of coupon area immersed. No blisters, cracks, flaking and rust spots after 4200h Pull-off test to ISO 4624, minimum 10,0 MPa and maximum 30% reduction from value measured before ageing.
19	Autoclave test	NACE TM0185 Test at 80°C with 50:50 of crude oil and 3% NaCl. Gas overpressure of 0.3MPa (90% CH_4, 10% CO_2)	No failure after 2016hrs.
20	Thermal cycling test	NACE TM 404 section 9	No failure regarding cracking and flaking

Note 1: Alternative verification method may be acceptable.
Note 2: 50% of atlas cell volume with solution. Solution composition: Chloride concentration = 70.000 ppm; Sodium acetate trihydrate concentration= 21 g/L; Initial pH = 5 (adjustment done with HCl).
Note 3: DEC is the equivalent diameter of the circle, calculated by formula $DEC = \sqrt{\frac{A}{0,785}}$ where: A is the area (in mm²) between the edge of the fault intentionally made in the sample and the edge of the paint that remains adhered to the substrate.

5.2.2. Additionally to the performance test related at the test protocol listed for each coating system, there are some requirements are applicable to paints to be used (see items 5.2.3, 5.2.4, 5.2.6, 5.2.7 and 5.2.8).

5.2.3. The zinc rich pre-fabrication primer shall have at least 25% solids by volume. For ballast tanks, the zinc-rich pre-fabrication primer shall meet the requirements according to Table 1 of IMO MSC.215 (82).

5.2.4. Zinc Rich Epoxy Primer shall sustain an electrochemical potential of 65 to 75mV for 30d in a solution of NaCl 3,5%.

5.2.5. Epoxy adherence paint is used to give adhesion to stainless steel alloy, galvanized steels and substrates of non-ferrous alloys. It shall follow the recommendations of the paint manufacturer.

5.2.6. Coating material for CuNi substrate shall not contain S and P.

5.2.7. Coating material for stainless steel shall not contain metallic zinc and reactive chloride.

5.2.8. ANTI-FOULING PAINT REQUIREMENTS

5.2.8.1. This is a tin-free antifouling paint whose efficiency is guaranteed up to 5 years of immersion under static conditions.

5.2.8.2. The antifouling coatings system for offshore production units shall have antifouling technology for static condition with proved efficiency.

5.2.8.3. The following technologies are recognized as acceptable:

a) Fouling release

b) Fouling defense

c) Silyl acrylate static

5.2.8.4. Other antifouling technologies shall be submitted for BUYER approval.

5.2.8.5. The minimum thickness of the film is 100 µm per coat by means of airless spray gun.

5.2.8.6. The paint manufacturer shall provide assurance on the performance of the anti-fouling system.

5.2.8.7. Tie coat is applied to ensure compatibility between the anti-corrosion system and the anti-fouling system.

5.3. ELASTOMERIC COATINGS PRE-QUALIFICATION

5.3.1. For elastomeric coating, the Elastomeric Polyurethane (PUR), Polyurea (PUA) and hybrid coatings containing these two chemical structures are the materials considered.

5.3.2. A COATING PROCEDURE TEST-CPT shall be used to qualify all elastomeric coating procedures as defined at NORSOK M-501.

Table 3 - Performance tests Elastomeric coatings

Performance test		Verification method	DFT	Acceptance criteria
Nº	Description			
1	Fingerprinting	ISO 12944-9 Annex C	-[1]	ISO 12944-9 Annex C
2	Cyclic ageing test	ISO 12944-9 Clause 9	3mm[1]	Pull-off test to ISO 4624, minimum 10,0 MPa
3	Edge retention	NACE TM204	3mm	>80%
4	Abrasion Test	ASTM D4060 (mg/1000 cycles), CS-17, 1kg.)	3mm	Max 50 mg
5	Impact test	ASTM D2794	3mm	>20J
6	Adhesion (Pull-Off Test), MPa	ASTM D 4541 or ISO 4624 Method D – Equipment types IV or Method E – Equipment Type V (hydraulic automatic)	3mm[1] -	Initial adhesion ≥10 MPa. Failure type: -/ Y, Y or Y/Z, B, B/C or C.
7	Hardness shore D	ASTM D2240	3mm	>35
8	Tensile strength (Die C or Type IV)	ASTM D412	2mm	>15Mpa
9	Elongation (Die C or Type IV)	ASTM D412	2mm	>10%
10	Water absorption @23°C, 7days	≤ 2 %	2mm	ASTM D471

Note: (1) The test shall include primer as applicable. The test shall be performed in a coat system carried out with the same conditions as field.

5.4. ELETROSTATIC COATING SYSTEMS PRE-QUALIFICATION

5.4.1. There are of two types, depending on location, whether in a controlled room or in the weather environment.

5.4.2. Type I Coating (C4 environment)

5.4.2.1. Apply one primer coat of epoxy powder paint by electrostatic process with minimum thickness of 90 µm. As a finishing paint, apply one coat of polyester paint, using electrostatic process, with minimum thickness of 80 µm.

5.4.3. Type II Coating (CX and C5)

5.4.3.1. Apply one primer coat of epoxy powder paint pigmented with metallic zinc, by means of process electrostatic, with a minimum thickness of 90 µm. As a finishing paint, apply 01 (one) coat of polyester paint, by electrostatic process, with minimum thickness of 80 µm.

5.4.4. The coatings shall meet the requirements described in Table 4.

Table 4 - Performance tests electrostatic coating

Tests	Minimum Requirements		Standards to be used
	Type I (170 µm)	Type II (170 µm)	
Cyclic Corrosion	25	25	ISO 12944-9
Resistance to sea water (3,5% NaCl) @40°C h	500	2000	ASTM D 1308
Resistance to distilled water @ 40 °C, h	2000	2000	ASTM D 870
Resistance to 100 % relative humidity, h	1500	1500	ASTM D 2247
Resistance to NaOH 10%, h	500	720	ASTM D 1308
Resistance to H_2SO_4 10%, h	500	720	ASTM D 1308
Resistance to MEC, seconds	30	30	Note 3
Adhesion (Pull-Off Test), MPa	12	12	ASTM D4541 (See Note 1)
UV-A Radiation and Condensation of Humidity Resistance, h	1440	1440	ASTM G 154 (See Note 2)

NOTE 1 The pull-off test shall be performed in accordance with ASTM D4541 or ISO 4624 using Pneumatic Equipment Type IV (Test Method D) or Automatic Hydraulic Equipment Type V (Test Method E)
NOTE 2 In this test, the cycle to be used is 8 h under UV-A radiation and 4 h under moisture condensation. After exposure time, the film shall not exhibit chalking. The gloss reduction shall not exceed 10% of the initial value.
NOTE 3 Curing is considered acceptable when, at most, there is a slight softening of the paint film without it becoming sticky, allowing for a slight variation in color. Curing is considered deficient when the paint film dissolves or fibers from the cotton used in the test adhere to the coating.

5.4.5. Surface preparation shall be done by means of a chemical process of phosphatization using phosphate (zinc or tricationic, as applicable), with mass between 2.0g/m² and 4.0g/m².

5.4.6. The responsible for surface preparation shall perform all sequential steps pertinent to a phosphating process as recommended by the manufacturer for pretreatment. The sequential steps are degreasing, washing, pickling, washing, refinement, and washing, passivation, washing with deionized water and drying.

5.4.7. Alternatively, conversion process with nanoceramic coatings may be performed at aluminum and stainless steel substrates.

5.5. FUSION BONDED EPOXY AND fluoropolymeric SYSTEMS PRE-QUALIFICATION

5.5.1. Qualification of coating by laboratory methods is required prior to production. Once qualification is made, no further qualification tests are required unless the coating materials or laboratory application methods change. For each qualified material, the supplier shall provide a qualitative analysis of properties. An acceptable method is an infra-red spectrum.

5.5.2. Coatings materials previously qualified by BUYER with same criteria may be accepted.

5.5.3. Table 5, Table 6, and Table 7 present the requirements for fusion bonded epoxy and fluoropolymer systems pre-qualification.

Table 5– Requirements for FBE/ FBE Novolac (ready to apply)

Tests	Requirements	Standards
Particle size	0,1% max retained on 60 mesh	CAN/CSA Z245.20 Subsec. 12.5
Cure cycle	Capable of cure at temperature below 260°C	-
Humidity	0,6%wt	CAN/CSA Z245.20Subsec. 12.4
Tg2	Maximum Operational temperature + 30°C, and least 95°C	CAN/CSA Z245.20Subsec. 12.7 ASTM D3418 ISO21809-2

Table 6– Requirements for FBE/ FBE Novolac (dry film characteristics)

Tests	Dry film thickness (µm)	Requirements		Standards
		Min.	Max.	
Atlas cell @ 80 ºC, h[1]	200-400	2000		ASTM C868
Autoclave @ 150 ºC, h1,2	200-400	2000		NACE TM0185
Abrasion resistance, mg/1000 cycles[3]	200-400		70	ASTM D4060
Pull-off strength, MPa	200-400	15		Note 4
Resistance to 100 % relative humidity, h	200-400	2000		ASTM D2247
Resistance to distilled water @ 40 °C, h	200-400	2000		ISO 2812-1
Resistance to NaOH 30%, h	200-400	2000		ISO 2812-1
Resistance to H2SO4 40%, h	200-400	2000		ISO 2812-1
Resistance to xylene, h	200-400	2000		ISO 2812-1
Elongation (%)	200-400	7		ASTM D522
Impact	200-400	1.7J		ASTM D 2794
Tg2	-	Maximum Operational temperature + 30°C, and least 95°C		CAN/CSA Z245.20Subsec. 12.7 ASTM D3418 ISO21809-2

NOTE (1): The solution to be used shall have the following composition: 70 000 ppm of chloride ions, 21 g/L of sodium acetate trihydrate, initial pH of 5, adjusted with hydrochloric acid.
NOTE (2) The gas phase shall be comprised of 96 % of CO_2 and 4 % of H_2S and, during the test, its pressure shall be kept sufficiently above the water vapor pressure at 150ºC to prevent the solution from boiling.
NOTE (3) The abrasion resistance test shall be performed using a CS-17 abrasive wheel with a load of 1 kg.
NOTE (4) ASTM D4541:2009, Method D - Equipment Typo IV

Table 7 – Requirements for fluoropolymeric coating

Tests	Min DFT (µm)	Requirements[1]	Standards
Melt flow rate (2,16 kg / 275°C) ([2])	N/A	0.7-1.3	ASTM D 1238
Melting point	N/A	220°C	ASTM D 3418
Density (1)	N/A	1.65-1.76	ASTM D 792
Tensile strength (23 ± 2) °C (2)	600	Min 39 Mpa	ASTM D638
Elongation at rupture (23 ± 2) °C ([2])	600	Min 200%	ASTM D638
Water absorption (23°C / 24h)	600	Max 0.3%	ASTM D570
Cure cycle	600	Capable of cure at temperature below 260°C	-
Abrasion resistance (CS 17/1kg)	600	30 mg/1000 cycles	ASTM D4060
Resistance to H_2S @120°C[3]	600	2000h	-
Gas Blistering	600	No blistering at coating film	API RP 5L2
Hydraulic blistering	600	No blistering at coating film	API RP 5L2
Tg2	N/A	Maximum Operational temperature + 30°C, and least 95°C	CAN/CSA Z245.20Subsec. 12.7 ASTM D3418 ISO21809-2

NOTE (1): Test to be performed on dry coat, the DFT shall be 300µm.
(2) test coupon type IV, with 50mm/min
(3) Immersion in H_2S medium:
-Duration: 2000 hours.
-Temperature: 120ºC.
-Pressure: vapor pressure at test temperature.
-Medium composition:
- Chloride concentration = 70000 ppm
- Sodium acetate concentration = 21 g / L
- pH initial = 5 (adjust with de HCL 37%)
- H_2S concentration= 4%

Table 8 - Coating system (CS) pre-qualification protocol

Table 2

Test required	Fingerprinting	Cyclic ageing test	Seawater immersion	Cathodic disbonding	Abrasion Test	Impact test	Flexibility	Hot/wet cycling	IMO RESOLUTION MSC.215	IMO RESOLUTION MSC.288	Atlas cell @ 60 ° C	Adhesion	ASTM G8	Chemical resistance	Atlas cell @ 80 ° C	Water immersion	Autoclave Test	Thermal cycling Test	Track Record
CS1	x		x	x	x	x													x
CS10	x				x						x	x	x	x				x	
CS11	x															x		x	x
CS12	x						x	x		x								x	x
CS14	x											x	x	x	x				x
CS15	x						x	x		x							x	x	x
CS16	x	x	x	x	x	x													x
CS22	x	x	x	x	x	x													
CS25	x						x	x	x										x
CS26	x						x	x	x								x	x	x

Table 2

Test required	Fingerprinting	Cyclic ageing test	Seawater immersion	Abrasion Test	Impact test	Friction coefficient	CUI	TABLE 3	TABLE 4	TABLE 5	TABLE 6	TABLE 7							
CS2	x	x																	
CS3	x	x	x	x	x														
CS4	x	x																	
CS5																			
CS6	x	x																	
CS7																			
CS8	x						x												
CS9	x	x			x	x													
CS13																			
CS17										x	x								
CS18										x	x								
CS19									x										
CS20	x	x							x										
CS21												x							
CS23								x											
CS24								x											

6. SELECTION OF PETROBRAS COATING SYSTEM

6.1. The coating systems described at ANNEX A are specified for each specific area to be coated in accordance with Table 9, Table 10, Table 11, Table 12, Table 13, Table 14 and Table 15.

6.2. The hard pipe shall receive an elastomeric coating in accordance with I-ET-3010.00-1200-217-P4X-001 - SUPPLEMENTARY SPECIFICATION TO ISO18797-1.

6.3. For coating of bolting and nut, SELLER shall refer to I-ET-3010.00-1200-251-P4X-001 - REQUIREMENTS FOR BOLTING MATERIALS.

6.4. The following materials shall receive the same coating system as carbon steel: low alloy steel, nickel alloyed steel (3,5Ni, 9Ni), ferritic stainless steel, and martensitic stainless steel. Exception 9 % nickel steel shall not be coated with metallic zinc based coatings.

6.5. The following materials shall receive the same coating system as austenite stainless steel: duplex stainless steel, superduplex stainless steel, superaustenic stainless steel and Ni alloys.

6.6. Maximum and minimum operating parameters (temperature and pressure) shall be used for coating selection.

6.7. Environmental and short-term conditions affecting the coating performance shall be considered by SELLER.

6.8. In case of passive fire protection coating requirements, the coating system shall be adequate for this purpose and follow the requirements of I-ET-3010.00-5400-433-P4X-001 – PASSIVE FIRE PROTECTION.

6.8.1. In case the coating system is applied on a shop-primer or any other exiting coating system of a different coating manufacturer, the coating manufacturer of passive fire protection must confirm the compatibility and integrity of the primer coating.

6.9. For structural tanks, any coated substrate inside the tank shall be coated with the correspondent Coating System at Table 14. The same is valid for coated internal parts of pressure vessels internally coated and tanks.

6.10. In case of a dissimilar welding between a CRA material and coated carbon steel, there shall always be a superposition of the coating over the CRA of at least 50 mm, as shown in Figure 1 below. If the indicated coating system for the carbon steel is not suitable for the CRA material, SELLER shall define a specific coating system for this purpose.

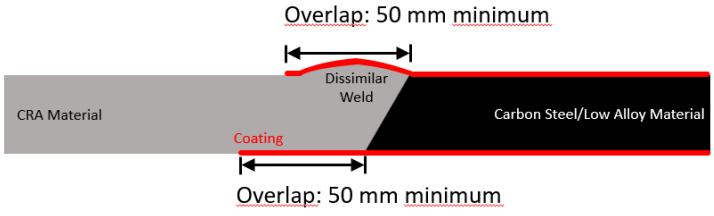

Figure 1 – Minimum superposition of 50 mm in transitions from coated carbon steel to CRA.

6.11. Table 12 requirement for electric and instrument is not applicable to ATEX equipment. In that case, and where operational maximum temperature is above 80°C, equipment manufacturer is responsible for the selection of suitable coating system.

6.12. Pultruded composite materials shall be applied in entire tertiary structure, such as: guardrail, floor grating and stairs (tread and guardrail), except for flare tower structure, laydown areas and drainage gratings at topsides pancake level. Carbon steels tertiary structures are only accepted in cases that the application of composite material is not allowed.

Table 9- Coating Systems for Hull Structures

Nº	Item	Maximum operational temperature	Coating system for carbon steel
1.1	Hull Topside	T≤ 80°C	3
1.2.	Splash zone (bootop)	T≤50°C	16
1.3.1	Underwater zone, including lower riser balcony and niche areas	T≤50°C	1
1.3.2	Underwater zone (fixed platforms)	T≤50°C	N/A
1.4	Upper Riser Balcony and Pull in Structure	T ≤80°C	22
1.5.1	Caisson - Internal coating (base line up to design draft line)	T ≤ 60°C	1
1.5.2	Caisson - Internal coating (above design draft line)	T ≤ 60°C	10
1.5.3	Caisson -External coating	Same as surrounding	
1.6	Deck Area	T ≤80°C	3
1.7	Forecastle deck; poop deck floor area	T ≤60°C	24
1.8	Supply Boat Handling Area	T ≤80°C	9
1.9	Lifeboat Platforms & Davits	T ≤80°C	3
1.10	Offloading Platform	T ≤80°C	3
1.11	Local Equipment Rooms + Laboratory	T ≤80°C	2
1.12	Warehouse and Mechanical Workshop Floor.	T ≤ 60°C	24
1.13	Engine Room/ Pump Room	T ≤ 80°C	6
1.14	Battery room	T≤80°C	10[2]
1.15	Walls and ceilings of HVAC / Controlled Rooms	T ≤ 80°C	6
1.16	Covered floors and uncovered floors of HVAC / Controlled Rooms	T ≤ 80°C	6
1.17	External atmospheric exposure of accommodation block	T ≤80°C	2
1.18.1	Escape Route	T ≤ 80°C	9
1.18.2	Walkways	T ≤ 80°C	9
Note (1): Other coating systems may be applied provided is confirmed the compliance with the specific environment of battery rooms.			

Table 10- Coating Systems for Special Structures

Nº	Item	Maximum operational temperature	Coating System	
			Carbon Steel	Austenitic Stainless steel[1]
2.1	Flare tower and pipping	N/A	7	7
2.2	Vent Post and piping (inside)	N/A	7	7
2.3.1	Telecom tower	T ≤ 80ºC	2	N/A
2.3.2	Telecom tower (HDG)	T ≤ 80ºC	HDG +5	N/A
2.4.1	Helideck Structure	T ≤ 80ºC	2	N/A
2.4.2	Helideck Landing Area	T ≤ 80ºC	23	N/A
2.4.3	Helideck Structure	T ≤ 80ºC	2	N/A
Note (1): See item 4.4.				

Table 11- Coating Systems for Topside Structures

Nº	Item	Maximum operational temperature	Coating System	
			Carbon Steel	Austenitic Stainless steel[1]
3.1	Process Module Structures	T ≤ 80ºC	2	4
3.2	Deck / Skid Structures of Process Modules	T ≤ 80ºC	3	4
3.3.1.	Central Pipe Rack, Steel Structures	T ≤ 80ºC	2	N/A
3.3.2	Pipe Rack Process Plant Deck Main Walkway	T ≤ 60ºC	24	N/A
3.3.3	Process Plant Deck Primary Escape Route	T ≤ 60ºC	23	N/A
3.4.1	Lay down area	T ≤ 80ºC	2	N/A
3.4.2.	Lay down area AFT (M-16)	T ≤ 60ºC	24	N/A
3.5.1	Escape Route	T ≤ 80ºC	9	N/A
3.5.2	Walkways	T ≤ 80ºC	9	N/A
Note (1): See item 4.4.				

Table 12- Coating Systems for Equipment, Piping and HVAC duct

Nº	Item	Maximum Operational temperature	Coating System	
			Carbon Steel	Austenitic Stainless steel[1]
4.1	Uninsulated or with perforated guards / metallic mesh equipment and piping	T < 80°C	2	4
		80°C≤T<200°C	4	4
		200°C ≤ T < 600°C	7	7
4.2	Insulated equipment and piping	-50°C ≤ T< 600°C	8	7
4.3	Vapor Service equipment and piping	-50°C ≤ T< 600°C	7	7
4.4.1	Valves (insulated/ uninsulated)	-50°C ≤ T< 200°C	4	4
4.4.2	Valves (insulated/ uninsulated)	200°C ≤ T < 600°C	8	7
4.5	Cu-Ni / Al equipment and piping	T ≤ 80°C	13	
4.6	HDG equipment and piping	T ≤ 60°C	HDG +5	
4.7	Sea water lift pump	T ≤ 80°C	N/A	6[2]
4.8.1	Crane	T ≤ 80°C	2	N/A
4.8.2	Crane Boom; Mooring Hawser Winch, Hose Reel	N/A	7	7
4.9	Pull in sheave trolley and overhead crane.	T ≤ 80°C	16	N/A
4.10.1	Electric and Instrument located at controlled room[3]	T ≤ 80°C	19	19
4.10.2	Electric and Instrument located at atmospheric exposure[3]	T≤80°C	20	19
4.11.1	HVAC Duct located at controlled room	T≤80°C	6	6
4.11.2	HVAC Duct located atmospheric exposure	T≤80°C	2	4
4.11.3	HDG HVAC Duct [3]	T≤80°C	HDG +5	

Note (1): See item 4.4.
(2) Other coating system may be selected by vendor of equipment.
(3) See items 8.1.3.1 and 8.3.1.2

Table 13- Coating Systems for Outfitting.

Nº	Item	Maximum operational temperature	Coating system
5.1.1	FRP Cage Ladders, Handrail, Guardrails[1]	T≤80°C	13
5.1.2.	Carbon steel Cage Ladders, Handrail, Guardrails[2]	T ≤ 60°C	HDG+5
5.2.1.	FRP Grating[1]	T≤80°C	13
5.2.2.	Carbon steel Grating	T ≤ 60°C	HDG
5.2.3	Carbon Steel Grating at Upper Riser Balcony	T ≤ 60°C	HDG +5
5.2.4	Carbon Steel Grating at Main deck elevation	T ≤ 60°C	HDG +5
5.3.1.	Carbon steel Supports (piping, electrical, instr., telecom) [3]	T < 80°C	HDG+5
5.3.2	Carbon steel Supports (piping, electrical, instr., telecom)	80°C≤T<200°C	4
5.3.3.	Carbon steel Supports (piping, electrical, instr., telecom)	200°C ≤ T < 600°C	7
5.4	Carbon steel Supports (piping, electrical, instr., telecom) at Flare tower or Vent post	N/A	7
5.5.	Carbon steel Supports of enclosed areas (C5 and C4 environment)	T≤80°C	Same as surrounding
5.6	Carbon steel Outfitting inside tank and process vessel	Same as surrounding	
5.7	Drain box, pitch box, mud box	T≤80°C	HDG
5.8	HDG structures[3]	T≤80°C	HDG+5

Note (1): Coating as per manufactured.
(2) See item 6.12.
(3) See item 8.1.4 and 8.1.5

Table 14- Coating Systems for Internal Coating of Tanks

Nº	Item	Maximum operational temperature [1]	Coating System	
			Carbon Steel	Austenitic Stainless steel
6.1.1	Cargo Oil Tanks	T≤ 60ºC	12	12
6.1.2	Cargo Oil Tanks	60°C< T≤ 80ºC	15	15
6.2.1	Water Ballast tanks	T≤ 60ºC	25	25
6.2.2	Water Ballast tanks	60°C< T≤ 80ºC	26	26
6.3	Slop Tanks (oily water)	T≤80°C	10	10
6.4	Settling Tank	T≤80°C	10	10
6.5	Produced Water Tanks	T≤80°C	10	10
6.6	Off-spec tank (Oil and water)	T≤80°C	10	10
6.7	Sludge Tank	T≤80°C	10	10
6.8	Bilge Water Settling Tank	T≤80°C	10	10
6.9	Equalization Unit	T≤80°C	10	10
6.10	Drain tank	T≤80°C	10	10
6.11	Void Spaces & Cofferdams	T≤80°C	6	6
6.12	Diesel Tanks	T≤ 60ºC	12	12
6.13	Hydraulic Tanks	T≤ 60ºC	12	12
6.14	Fuel Oil Tanks	T≤ 60ºC	12	12
6.15	Potable, Fresh, Distilled Water Tank	T ≤40ºC	11	11
Note (1): For structural tanks, this is the same as design temperature. See item 7.1.1				

Table 15- Coating Systems for Internal Coating Pressure Vessels and Piping.

Nº	Item	Fluid	Maximum operational temperature	Coating System	
				Carbon Steel	Austenitic Stainless steel
7.1.1	Pressure Vessel	Process water, utility water, sea water	T≤120°C	14	14
7.1.2	Pressure Vessel	Hydrocarbon liquids, gases and produced water	T≤120°C	14	14
7.1.3	Pressure Vessel	Heating process water	T≤175°C	14	14
7.1.4	Pressure Vessel	Diesel/ Fuel	T≤60°C	12	12
7.1.5	Pressure Vessel	Air	T≤60°C	25	25
7.1.6	Pressure Vessel	Potable, Fresh, Distilled Water	T ≤40°C	11	11
7.2.1	Piping	Process water, utility water, sea water, hydrocarbon liquids, gases and produced water	T≤70°C	17	N/A
7.2.2	Piping	Process water, utility water, sea water, hydrocarbon liquids, gases and produced water	T≤120°C	18	N/A
7.2.3	Piping	Highly corrosive services, chemicals; acid cleaning	T≤180°C	21	21

7. SPECIFIC REQUIREMENTS

7.1. SPECIFIC REQUIREMENTS FOR HULL AND STRUCTURAL TANKS

7.1.1. For hull structural tanks coating system selection, SELLER shall consider the design temperature defined for each tank or each bulkhead (when bulkhead temperature is specified), as informed on specific project document [I-DE-HULL STRUCTURAL TANKS TEMPERATURES].

7.1.1.1. The design temperature of structural tank is considered the maximum operational temperature of the structural tank and shall be refereed to while using Table 14.

7.1.2. Bulkheads separating tanks with different temperatures may have its design temperature increased, in the colder tank, to account for adjacent tank higher temperature. On this case, more than one coating system may be applied at one structural tank.

7.1.3. For hull and structural tanks, the preparation grades of welds, edges and other areas with surface imperfections shall be according to grade P3 of ISO8501-3, including weld profile.

7.1.4. For blocks erection joints, the borders/ends of plates and stiffeners/reinforcements shall be left unpainted to avoid welding contamination/defects (see Figure 2). The unpainted area shall be touch up only after all welding tests and inspections are approved.

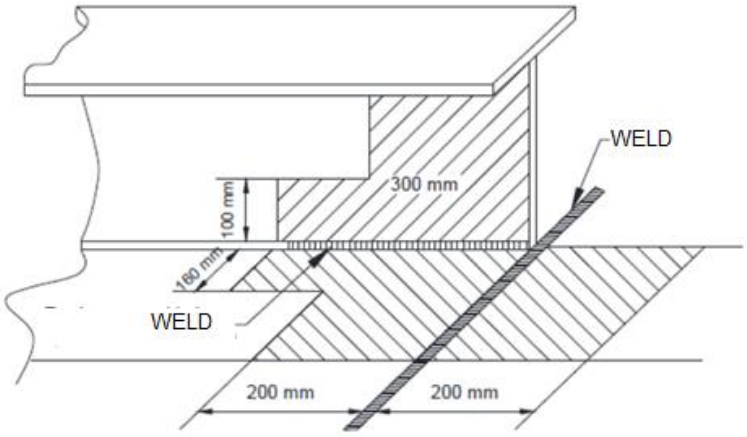

Figure 2- Block joints.

7.1.5. Cargo Tanks: coating shall be applied according to the instructions below, unless otherwise specified:

7.1.5.1. UPPER AREA - Tank Top Plating Internal Surface and all steel surfaces including reinforcements, transverse and longitudinal bulkheads and their associated stiffeners up to 4000 mm counted from tank ceiling (Figure 3).

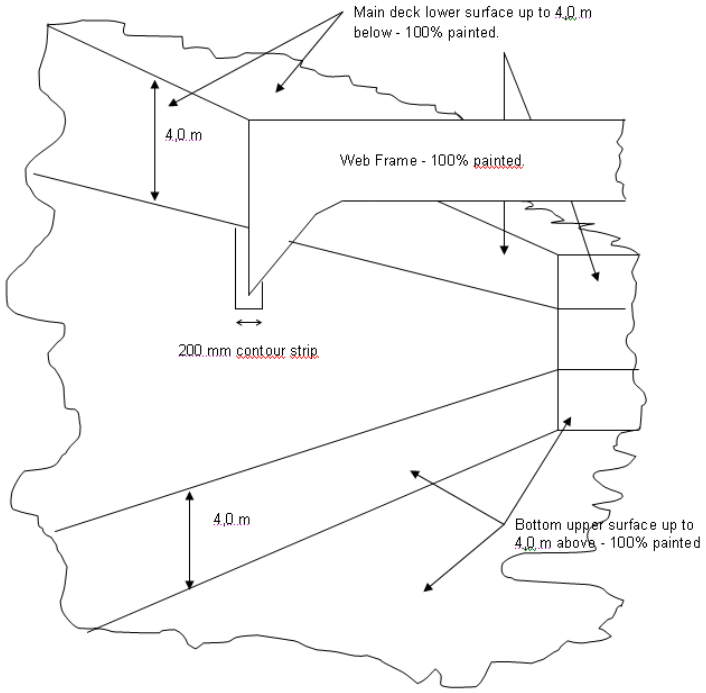

Figure 3 – Minimum regions of painting inside cargo tanks.

7.1.5.2. UPPER AREA (WEB FRAMES) – deck transverse web frames 100% coated including a contour strip of 200mm width around the web bracket (Figure 3 and Figure 5).

7.1.5.3. LOWER AREA - Tank Bottom Plating Upper Surface and all steel surfaces including reinforcements, transverse and longitudinal bulkheads and their associated stiffeners up to 4m from Bottom (Figure 3 and Figure 4).

7.1.5.4. LOWER AREA (WEB FRAMES) – bottom transverse web frames 100% coated including a contour strip of 200 mm width around the web bracket (Figure 5).

7.1.5.5. TRANVERSE BULKHEADS (HORIZONTAL STRINGERS & BRACKETS) – top surface of horizontal stringers and brackets (including internal side of flanges and top surfaces of horizontal brackets attached to longitudinal bulkheads) up to 300 mm above the top surface of stringers & brackets (strip coated on the surface of transverse and longitudinal bulkhead) (Figure 4, Figure 6, Figure 7, Figure 8 and Figure 9).

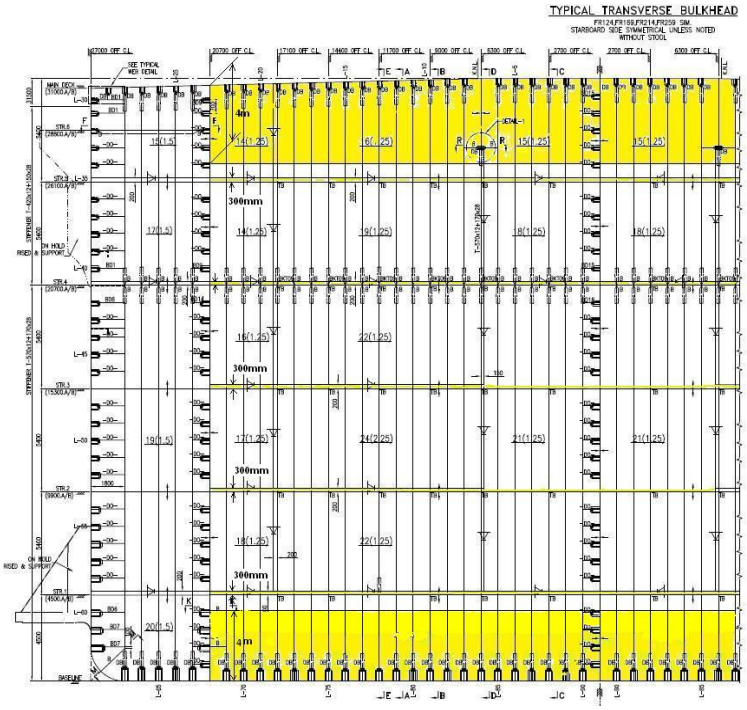

Figure 4 - Upper and lower area of cargo tanks at transverse bulkhead.

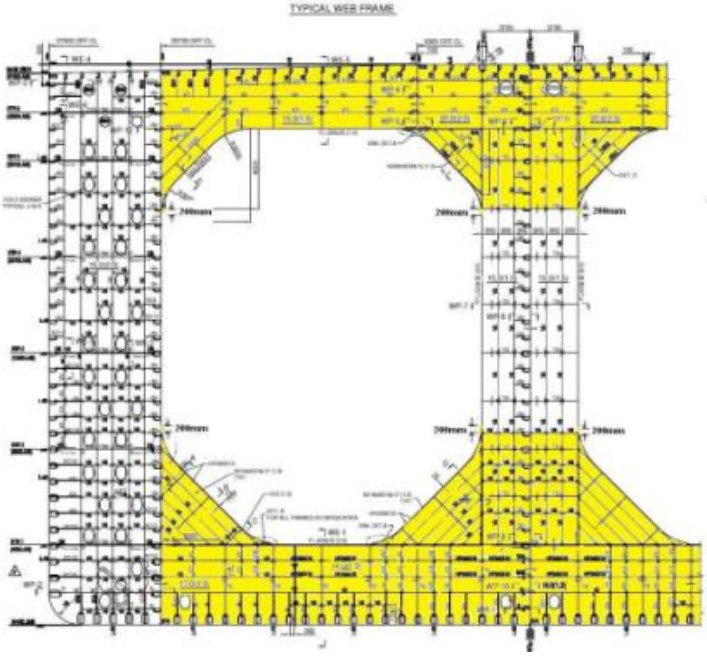

Figure 5- Web frame at cargo tanks.

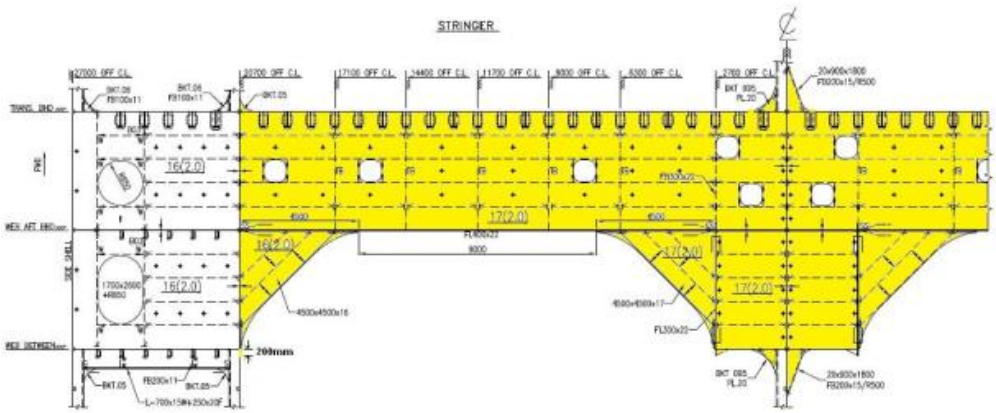

Figure 6 - Transverse bulkheads (horizontal stringers & brackets) – Top view.

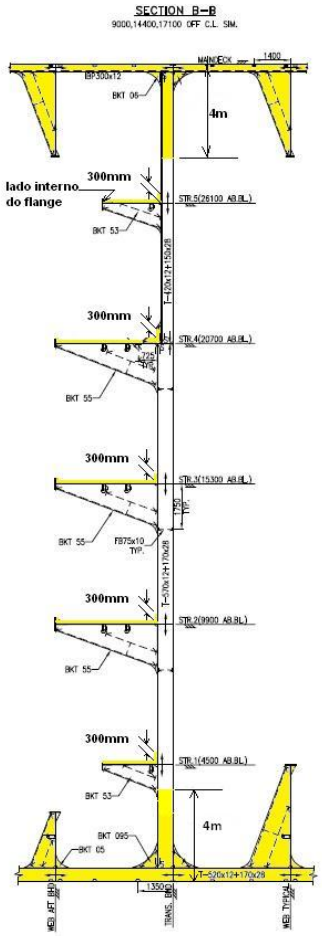

Figure 7 - Transverse bulkhead horizontal stringers and stiffeners, longitudinal and tripping brackets - transverse view.

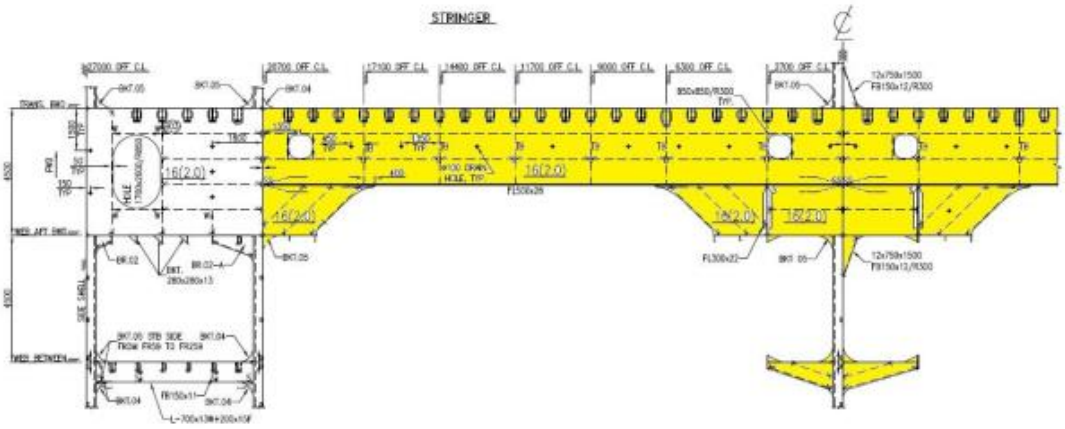

Figure 8- Transverse bulkheads (horizontal stringers & brackets) – Top view.

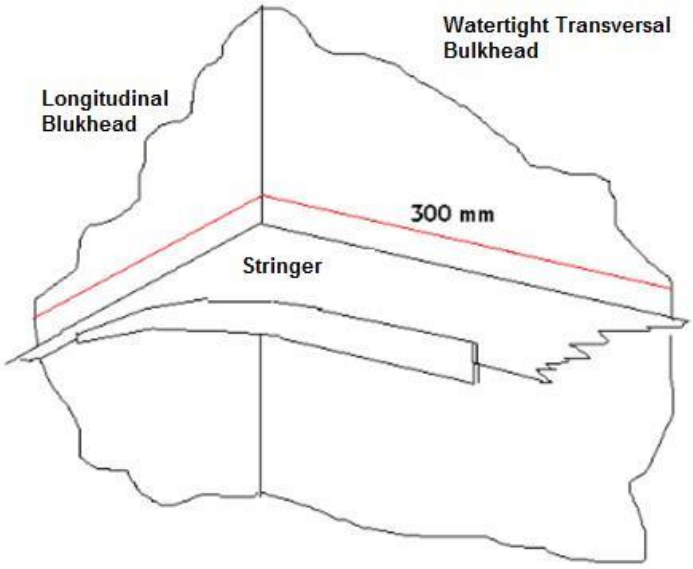

Figure 9- Schematic drawing of stringer and is adjacent structures.

7.1.6. VOIDS AREAS, BALLAST, SETTLING, SLOP, PRODUCED WATER AND OFF-SPEC TANKS: Coating system shall cover 100% of surface area.

7.1.7. The structural tanks shall observe the requirements of I-ET-3010.00-5267-750-P4X-002-TECHNICAL SPECIFICATION FOR GALVANIC ANODES

7.1.8. Portable pump caisson internal caisson shall be coated with the same coating as structural tank coating it located.

7.1.9. An anti-abrasion coating shall be applied at double plates of tanks (ballast, cargo and others as specified).

7.1.9.1. The anti-abrasion coating is an 100% solid reinforced with ceramic composite coating specially developed with high resistance to abrasion-corrosion. The coatings shall meet the

requirements of Table 16.

7.1.9.2. The BUYER may waive performance of existing abrasion composite coating systems based on relevant, documented testing or field experience.

Table 16 -Performance tests – anti- abrasive coating

Tests	Requirements		Standards to be used
	Min.	Max.	
Atlas cell @ 60 ° C	2000	-	ASTM D6943
Autoclave immersion	2000	-	NACE TM 0185
Abrasion (1000 cycles)		7 mg	ASTM D4060 (CS17)
Note (1): Temperature = 150 °C. Pressure: Water vapor pressure at 150 °C. Solution composition: Chloride concentration = 70000 ppm. Sodium acetate trihydrate concentration = 21 g/L. Initial pH = 5 (adjustment done with 37% HCl). Composition of the gas phase: 96% CO_2; 4% H_2S Condition stagnant and desaerated.			

7.1.9.3. The anti-abrasion coating shall be applied over the area of the double plate and a 150mm area adjacent to it as presented at Figure 10.

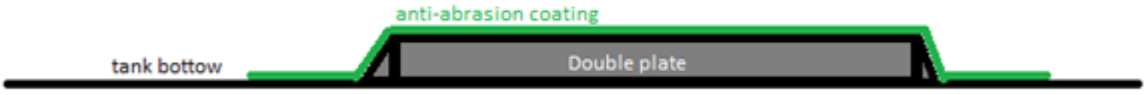

Figure 10 – Detail of anti-abrasion coating at double plate.

7.1.10. The hull painting shall observe the requirements of I-ET-3010.00-1000-950-P4X-001- MARINE BIOFOULING and I-ET-3010.00-5267-750-P4X-001- TECHNICAL SPECIFICATION FOR CATHODIC PROTECTION.

7.1.11. Impressed Current Cathodic Protection (ICCP) shield area shall be coated as required by I-ET-3010.00-5267-750-P4X-001- TECHNICAL SPECIFICATION FOR CATHODIC PROTECTION.

7.2. SPECIFIC REQUIREMENTS FOR PIPING AND EQUIPMENT

7.2.1. In the case of insulated equipment and piping where some parts are not insulated such as flanges and eyebolt, it is acceptable the use of same coating system for the whole component. This is not valid for shell and tube exchangers, where the shell and the tube are considered each a component.

7.2.2. The coating of the flange shall be up to the sealing area (contact area), except for internally coated piping and CRA compact flanges. For CRA (substrates classified as austenitic stainless steels) of API 6A and ISO 27509 flanges shall be coated as detailed in Figure 11.

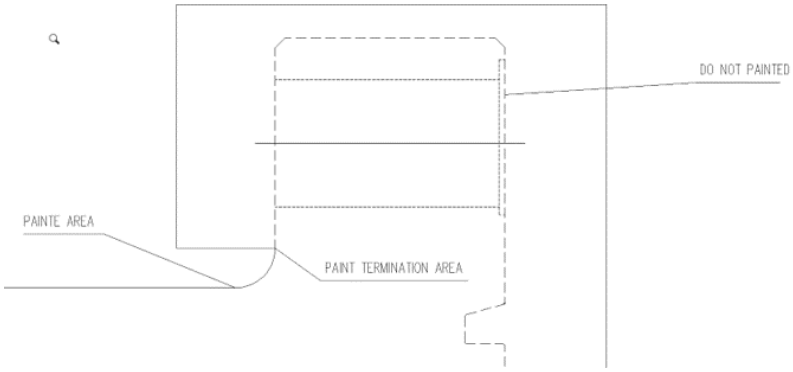

Figure 11 – Coated and not coated area of compact flange.

7.2.3. The outer flange corners of carbon steel flanges shall be rounded to the radius indicated in Table 17. Tolerance for corners radius is +2,0mm, -0,0 mm.

Table 17 – Minimum radius required at flange outer corners.

NPS	Radius, mm
½ to 6	1
>8	1,5-3

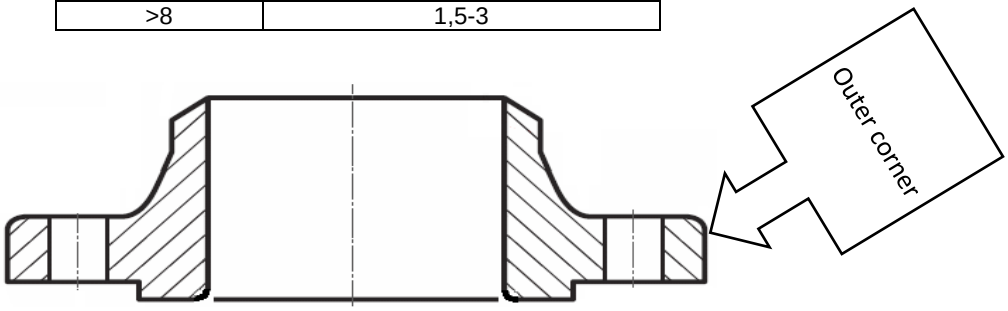

Figure 12 -Details of substrate preparation of flange.

7.2.4. Carbon steel bolts and nuts of flange connections of immersed areas structural tanks shall be fully painted after commissioning tests.

7.2.5. For fire water piping system accessories made of carbon steel (e.g., bling flange and spectacle), the area in contact with sea water fluid shall receive a thermal spray be according to the requirements of I-ET-3010.00-1200-956-P4X-003, except that the consumable shall be bronze aluminum according to AWS C2.25M: W-CuAl-1 or ISO 14919: CuAl10. The carbon steel loose flange shall be HGD coated.

7.2.6. The part of the pipe that penetrates a sealed or closed pipe penetration shall be coated according to the coating requirements for insulated pipes. The pipe shall be coated in the pipe penetration area and 50 cm (20 in) on both sides of the penetration regardless of the material grade.

7.2.7. Pipe penetration sleeves shall be coated prior to running the pipe.

7.2.8. Saddles, support plates, wear pads and belts and supports shall be coated before installation.

7.2.9. Spring supports and vibration damping devices shall be metallized with aluminum by thermal spray according to I-ET-3010.00-1200-956-P4X-003.

7.3. SPECIFIC REQUIREMENTS FOR FLARE SYSTEM AND HIGH STRUCTURAL COMPONENTS

7.3.1. All surfaces at Flare Tower, including structures, outfitting and piping shall receive thermal spray coating, without considering temperature of substrate.

7.3.2. In case of surfaces subject to temperatures higher than 500°C due to flare radiation, the flare manufacturer shall specify coating material adequate to the limits of low and high temperature of operation.

7.3.3. SELLER shall observe the Flare Radiation and Dispersion Analysis report to determine the piping systems and equipment affected by flare radiation. The operational temperature shall consider the impact of flare radiation in addition to the operational temperature for determination of coating system.

7.4. SPECIFIC REQUIREMENTS FOR PIPING INTERNAL COATING

7.4.1. The criteria used for the piping system spooling shall consider the coating applicator capabilities for coating execution. Pipe NPS 4 and smaller shall be used only for short-length branch connections, where the coating application is feasible.

7.4.2. For pipping internal coating, it is required a P3 preparation grade (ISO8501-3) for all imperfection on whole internal surface of the piping, including:

a) pressure retaining full penetration welds.

b) openings (branches) and flanges edges

7.4.3. Weld Neck flange welding and all accessible welding internal weld shall be ground flush. Non-accessible welding shall be ISO8501-3 P3 with a maximum height of 1.5mm.

7.4.4. Partial penetration for pressure retaining welds is not acceptable. Socket welds are not allowed.

7.4.5. All branch connections shall be full penetration welds, as in “tees” or in integrally reinforced branch pieces. Branch connections that are connected by anything different from full penetration welds or that may result in any kind of crevice shall not be used.

7.4.6. Openings for branches (including o-lets) shall have its internal edges prepared (rounded) before welding the accessory/branch to the header.

7.4.7. All field connections of the spool shall be flanged.

7.4.8. Visual (with aid of borescope) inspection of 100% of the length of the welds (root and face side) shall be performed, and the following is not acceptable:

a) Lack of penetration.

b) Lack of fusion.

c) Excess penetration.

d) Root undercut.

e) Cracks.

f) Pores.

g) Any defect that may affect the continuity of the coating.

7.4.9. All branch connections shall be short enough so that the visual inspection of the root of the connecting weld can be performed, as well as to facilitate the application of the coating and to perform the inspection that comes after coating.

7.4.10. All sharp corners in the branch connections shall be ground to a minimum radius of 5 mm (Figure 13).

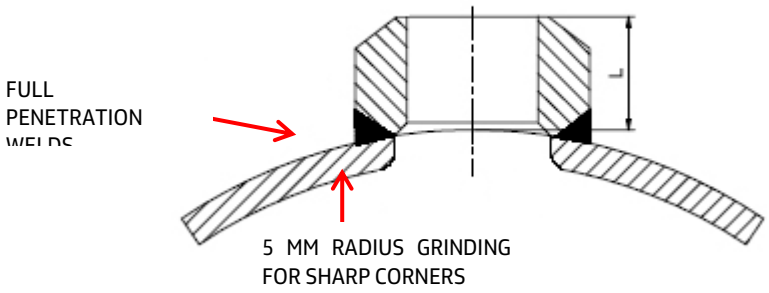

Figure 13 – Branch connections shall always be connected with full penetration welds, so that no crevices are formed. Sharp corners shall be ground to 5 mm minimum radius.

7.4.11. All NDT shall be finished, and all welds approved before applying the coating. Pressure tests as required by the design codes of the lines/equipment shall be performed and approved before applying the coating.

7.4.12. Flanged connection in between internally coated flanges and between internally coated flange to carbon steel flange, the Flat Face (FF) flanges shall be coated through all contact surface (Figure 14) and the Raised Face (RF) flanges shall be coated through all raised portion (Figure 15). The FBE coating may be applied in the region of bolting.

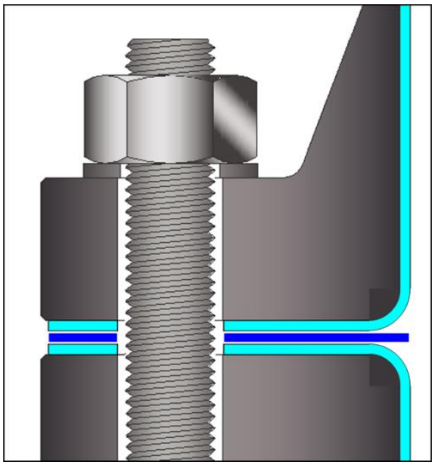

Figure 14 – Coating (light blue) in FF flange.

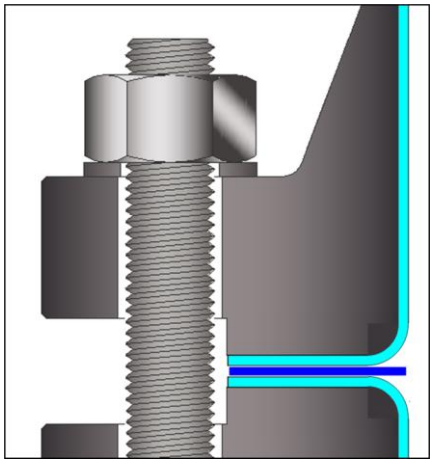

Figure 15 – Coating (light blue) in RF flange.

7.4.12.1. After applying the coating all flange faces shall be protected with a plastic or wood cover.

7.4.13. The application procedure for piping internal coating shall be qualified before starting the work for each shop site and coat system. The procedure shall cover only one process (airless spray, electrostatic, fluid bed and rotational molding) and its operation (manual, automatic or mechanized).

7.4.14. The procedure qualification shall demonstrate FBE (or fluoropolymer) applicator declared capability.

7.4.15. Test coupons shall reproduce spool geometry and size configurations. Complex geometry spools qualify less complex geometry spools 500mm minimum and the curves shall be 45°. of the same diameter. The stated maximum length shall be always considered for this qualification at each diameter qualified. The qualification process shall be aligned in specific meeting between the parties.

7.4.16. Small diameter spool qualifies bigger diameter spool of the same configuration with the following restrictions:

h) change in blasting tool require new qualification.

i) change in application tool or method require new qualification.

7.4.17. The smallest diameter spool declared by coating applicator within the scope of the project shall be qualified.

7.4.18. Table 18 presents the acceptance criteria for the qualification process. Specimens to be tested shall be the same material specification as the piping to be coated.

Table 18 – Requirements coating applied at spool (qualification process)

Tests	Requirements	Standards
Visual	100% free of defects, like: - curing; - contaminations; -solvent retention; -pinholes/ popping; -sagging; -surface defects	
Roughness	50- 100µm	ISO 8503-5 / ISO 8503-4
Soluble Salt	2 $\mu g/cm^2$	ISO 8502
Thickness	According to Table 14	ISO 19840
Adhesion	12 MPa	ASTM D4541, Method D - Equipment Type IV
Tg /Tm	Maximum Operational temperature + 30°C, and least 95°C	CAN/CSA Z245.20 Subsec. 12.7
Delta TG	5>ΔTg>-2	CAN/CSA Z245.20 Subsec. 12.1
Impact	1,7J	ASTM D 2794
	No holidays (100%)	NACE SP0188

7.4.19. The applicator shall handle, mix and thin the coating materials in accordance with the supplier recommendations or as directed by an authorized, qualified technician of the supplier. Coating thickness shall be in accordance with the CS 17 or CS18.

7.4.20. Over thickness may be accepted under previous BUYER approval. In no case the over coating shall impair process flow. The maximum thickness shall never be higher than 200% the qualified thickness.

7.4.21. FBE applicator shall register all spools that presented defect. The defect mapping shall have:

a) Position: Welding or Base material

b) Location: Welding joint number, spool item (curve, nipple, etc).

c) Quantity per spool

d) Type of defect: holiday, visual, DFT, etc.

7.4.22. Spools with holiday defect or defect that repair need surface preparation through bare steel, shall be kept less than 5% in quantity of spool for each applicator.

7.4.23. The repair procedure shall follow FBE (or fluoropolymer) manufacturer coating material and instructions.

7.4.24. If a defect is identified in a welding joint the root cause shall be identified. If the cause is a welding defect, the spool shall be rejected and send to piping manufacturer.

7.5. SPECIFIC REQUIREMENTS FOR PRESSURE VESSEL AND TANKS INTERNAL COATING

7.5.1. Equipment to be lined shall be sufficiently rigid that there is no possibility of deformation, which would result in damage to the lining during transportation, installation and operation. The arrangements for the lifting of the equipment shall be determined at the design stage.

7.5.2. Structural support members should be installed on the exterior of the vessel and/or equipment. However, if such members are installed internally, they shall be fabricated of simple shapes such as smooth round bars or pipe for ease of applying the lining material.

7.5.3. The design of all equipment shall allow for access during the preparation of the surface and application of the lining and for venting of fumes evolved during the operation. In completely enclosed vessels there shall be at least one manhole with a minimum diameter as large as practical for the vessel being lined and additional branch or openings should be provided in order to allow an adequate circulation of air.

7.5.4. Pressure vessel internal fittings which have to be installed after completion of the lining process shall be designed to be lined or fabricated from materials that will not be affected by the process conditions.

7.5.5. All field connections of the spool/equipment shall be flanged.

7.5.6. The bore of any internal fitting bolt hole shall be dimensioned for the diameter of the bolt plus the lining system thickness.

7.5.7. The pressure vessels nozzles bore diameter shall be larger enough in order to allow access for coating the nozzle with the lining.

7.5.8. Equipment internal surface, as well as equipment internal accessories (stiffeners, supports, etc.) welded to equipment walls or structure, shall be totally coated. Other accessories shall be analyzed by BUYER, to determine if they shall be coated or not.

7.5.9. Pressure tests as required by the design codes of the equipment shall be performed and approved before applying the coating.

7.5.10. For pressure vessels, it is required a P3 preparation grade (ISO8501-3) for all imperfection on whole surface of the vessel, including (see item 7.5.10.1):

a) pressure retaining full penetration (butt) welds.

b) internal/external accessories full penetration welds

c) internal/external accessories filet weld

d) internal/external accessories edges

e) openings (nozzles) and flanges edges

7.5.10.1. The welds of pressure vessels shall be with a flush weld (AWS A2.4) condition.

7.5.11. It is not acceptable a partial penetration for pressure retaining welds.

7.5.12. . Corner or lapped joints for pressure retaining components is not acceptable.

7.5.13. Intermittent welds for internal or external accessories are not acceptable.

7.5.14. Weep holes (in reinforcing plates) shall be plugged with a threaded bar and ground flush after the welding is finished.

7.5.15. Socket welds are not allowed.

7.5.16. All welds shall have been finished and properly inspected before applying the coating.

7.5.17. All sharp corners in the flange faces shall be ground to a minimum radius of 5 mm (Figure 16).

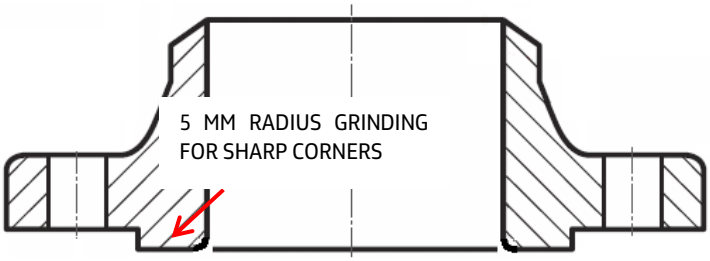

Figure 16 – Flange sharp corners shall be ground to 5 mm minimum radius.

7.5.18. Flanges

7.5.18.1. Internal organic coating shall be applied only for Flat Face (FF), Raised Face (RF) or Ring Type Joint (RTJ) flanges. It shall not be applied to compact type flanges, or any other type of mechanical connection or coupling.

7.5.18.2. The internal coating shall extend as detailed shown on the Figure 17 and Figure 18. The connection in between internally coated flanges and between internally coated flange to carbon steel flange shall be according to Figure 17. The connection between internally coated flange to CRA or non-metallic flanges shall be according to Figure 18.

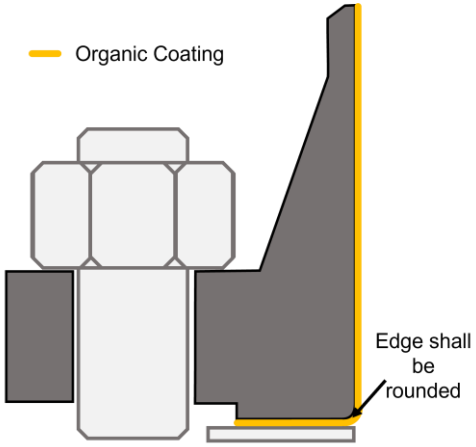

Figure 17 – Flanged connection in between internally coated flanges and between internally coated flange to carbon steel flange.

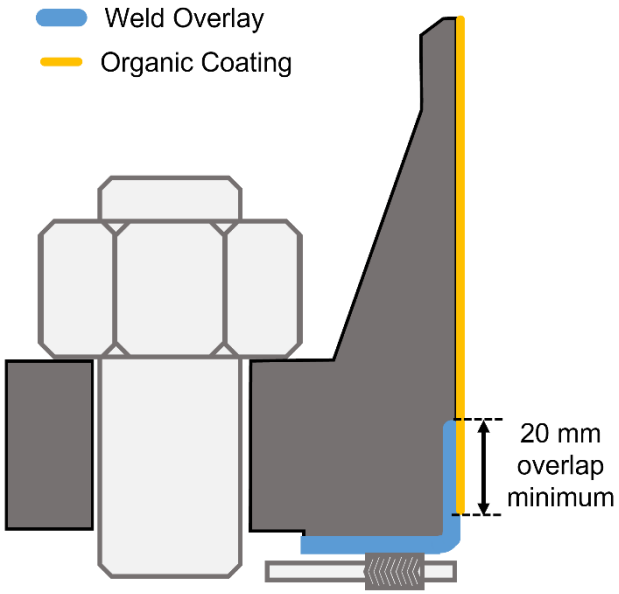

Figure 18 – Flanged connection in between internally coated flange to CRA or non-metallic flanges.

7.5.18.3. All sharp corners in the flange faces shall be ground to a minimum radius of 5 mm (Figure 16).

7.5.18.4. Flanged connection in between internally coated flanges, the Flat Face (FF) flanges shall be coated through all contact surface (Figure 14) and the Raised Face (RF) flanges shall be coated through all raised portion (Figure 15). After applying the coating all flange faces shall be protected with a plastic or wood cover.

7.5.19. For pressure vessel internal coating, PAINT MANUFACTURER shall give assistance during painting application and validade the painting application procedure and painting execution plan items:

a) Abrasive to be used and roughness profile.

b) Surface preparation between coats.

c) Number of coats.

d) Stripe coat (method of application and sequence of execution)

e) Paint application equipment, nozzle specification, pre-heating (when applicable)

f) Paint ratio mixture and ambient conditions.

g) Coat applicator infrastructure to mix, apply and cure the coating int he required temperature.

h) Sequence of blasting inside equipment (area division and equipment position changing)

i) Sequence of painting inside equipment (area division and equipment position changing)

j) Job sequence and time interval between coat (Overcoat window).

7.6. SPECIFIC REQUIREMENTS FOR COLOR CODING

7.6.1. Color specification for coating systems, required identification of equipment, pipelines, structures, etc., or for safety reasons, is according to DR-ENGP-I-1.15- COLOR CODING and NR-37.

7.6.2. Bright and light colors shall be selected for internal coatings of tanks and confined spaces in order to facilitate the visual identification of corrosion spots during inspections where paint is required.

7.6.3. If the coating system due to its technology have limited availability of colors, SELLER shall use adhesive stripes for safety identification, and the coating system shall be as close as possible to the required.

7.6.4. When applying adhesive stripes, those shall be multilayer material with polyester base material and topcoat, pre-coiled type, resistant to friction, bad weather, UV rays, oils, alkalis, weak acids, common solvents and be suitable for operational piping temperature. Adhesive specification shall have a minimum expected outdoor durability of 10 year. The adhesive stripe shall present a successful track record of installation at offshore production units form more than 10 years.

8. HOT DIP GALVANIZING (HDG)

8.1. HDG GENERAL REQUIREMENTS

8.1.1. The minimum average coating mass (and equivalent thickness) on any individual test area of the hot dip galvanized articles shall be as follows:

a) Steel 5 mm thick and over 705 g/m² (100 µm).

b) Steel under 5 mm thick but not less than 2 mm: 450 g/m² (63 µm).

c) Steel less than 2 mm: 350 g/m² (49 µm).

d) Centrifuged work: 300 g/m² (42 µm).

e) Threaded work: 300 g/m² (42 µm).

f) Gray and malleable iron casting: 600 g/m² (84 µm).

8.1.2. The galvanized coating on semi-finished products such as wire, tube or sheet, galvanized in specialized or automatic plants shall have the following minimum average coating mass, unless otherwise specified:

a) Wire: 300 g/m² (42 µm).

b) HVAC Sheet: 275 g/m² (Z275).

8.1.3. The following standards shall be applied on galvanized products:

a) ASTM A123 for structural and piping components.

b) ASTM A153 for threaded components.

c) ISO 1461.

8.1.3.1. For sheets and steel with less then 2mm it is acceptable to use a AZM180, Aluminum-Zinc Alloy in accordance with ASTM A792, alternatively to pure zinc HDG. In that case, no further coating process is necessary.

8.1.4. The HDG shall be performed on fabricated components and spools. Outfitting established to be HDG as per Table 13 shall be so after fabrication of component and prior assembly at main structure.

8.1.5. The HDG requirement may be waived in case of big/ small size outfitting (supports / structures):

a) An element that does not fit a box of 5000x2000x2000mm does not have to be HDG.

b) An element that fits a box of 50x100x100mm does not have to be HDG.

c) An element made of plates with thickness >8mm does not have to be HDG.

d) All angle bar perforated plate (e.g. oblong hole angle profile) shall be HDG.

8.1.6. HDG shall not be used under insulation or immersed in water at operational temperatures over 50°C.

8.1.7. HDG shall not be used on areas subjected to high temperature, above 400°C, due to the risk of Liquid Metal Embrittlement of stainless-steel material.

8.1.8. In no case materials with yield strength greater than 355 MPa shall be galvanized.

8.2. HDG SURFACE PREPARATION

8.2.1. HDG surfaces shall be de-greased using an alkaline, emulsifying detergent followed by rinsing with potable water and sweep blasting using non-ferrous abrasive in conformance to SSPC SP 16.

8.2.2. The abrasive shall be dimensioned to promote the profile without removing the entire zinc layer. The roughness profile shall be 20 to 30 µm.

8.2.3. No defects, break through or crisping of the zinc layer shall be permitted.

8.2.4. If the galvanized surface presents white corrosion, the surface preparation shall consist of washing with fresh water and removal of the zinc oxide layer with nylon brushes. Sandpaper is not indicated.

8.3. HDG COATING

8.3.1. HDG surfaces shall be externally painted as required in ANNEX A (CS 5 - Coating System Nº 5).

8.3.1.1. Alternatively, an electrostatic coating may be applied over the HDG surface for gratings.

8.3.1.2. For thin sheet it is acceptable the use of coil coating in accordance with EN 10169 adequate for the environmental condition.

8.3.2. For damaged coated areas greater than 10 cm², with substrate exposed, a new galvanization shall be done, except for cases where the structure is installed and welded. In these cases, the repair may be carried out by paint, subject to prior approval. Alternatively, a Thermal spray zinc may be performed.

8.3.3. For repair of areas without substrate exposed, or areas lower or equal than 10 cm² the surface shall be prepared with SSPC SP 11 Power Tool Cleaning to Bare Metal and coated with CS 2 -Coating System Nº 2.

9. PERSONNEL QUALIFICATION AND CERTIFICATION

9.1. Qualification and certification shall be in accordance with I-ET-3010.00-1200-970-P4X-003 - REQUIREMENTS FOR PERSONNEL QUALIFICATION AND CERTIFICATION.

10. DELIVERY/RECEIVING INSPECTION & STORAGE OF COATING MATERIAL

10.1. ABRASIVE MATERIALS

10.1.1. Non-metallic abrasives shall meet the requirements of ISO 11126 - Parts 1 to 8. Tests and controls shall be done according to ISO 11127 - Parts 1 to 7

10.1.2. Metallic abrasives shall meet the requirements of ISO 11124 - Part 1 to 4. Tests and controls shall be done according to ISO 11125 - Parts 1 to 7.

10.1.3. Only non-metallic abrasives or metallic stainless steel abrasives shall be used for abrasive blast-cleaning of stainless steels.

10.1.4. Abrasives materials shall produce an angular profile on the surface of interest.

10.1.5. All abrasive materials shall be tested for water-soluble salts content. The control shall be done according to ASTM D4940. The conductive shall be lower than 150 µS/cm.

10.2. COATING MATERIAL

10.2.1. The following test/inspections shall be performed on the delivery material:

a) Storage of coating material.

b) Containers and packaging integrity.

c) Shelf life validity of coating materials.

d) Compliance of all documents (shipping, MSDS, PDS, etc.).

10.2.2. For each batch of coating material received, SELLER shall compare the results of the quality certificate issued by the Paint manufacturers with the coating material specification.

10.2.3. Any shipment document(s) shall include, at least, information about:

a) Date of shipment.

b) Name of paint manufacturer to which shipment was made.

c) Brand names of product identification numbers.

d) Batch or lot numbers.

e) Quantity of paint materials.

10.2.4. Coating materials that shelf life has been exceeded shall be removed from the store and properly disposed of.

10.2.5. All products that become altered for any reason or show the container partially or totally destroyed and/or damaged shall be removed from the store, not be used for the coating work and properly be disposed of.

10.2.6. Any coating material containers shall have a legible label with name of painting manufacturer, product's brand name and batch or lot number, and seal unbroken. Containers which do not have legible

label or have seal broken shall be removed from the store and properly disposed of.

10.2.7. Consumables such as paints and varnishes will be stored in a sheltered place with the temperature range of 4°C to 38°C, or in accordance with paint manufacturer instructions.

10.2.8. The powdered epoxy and polyester shall be stored at least 10 cm of the soil at a temperature not exceeding 27 °C and relative humidity of 70% or less. Conditions shall be monitored and recorded continuously.

11. PREPARATION GRADES OF WELDS, EDGES AND OTHER AREAS WITH SURFACE IMPERFECTIONS

11.1. The standard preparation grades of welds, edges and other areas with surface imperfections shall be according to grade P3 of ISO8501-3, except for weld profile that shall follow grade P2.

11.1.1. The weld profile for hull and structural tanks shall be grade P3 as stated at 7.1.3.

11.1.2. Specific requirements for pressure vessel internal coating and piping internal coating are provided at items 7.4 and 7.5.

11.1.3. When indicated in the weld detail drawing, the weld ripple/profile is required to be in flush weld (AWS A2.4) condition.

11.2. Welding shots drops and spatters, pores in welding seams, lamination defects, edges, flame cuts, fragments and dents or any other foreign material not removed during construction have to be considered imperfections and, therefore, shall be removed before surface preparation.

11.3. Crevices, corners and low portions hard to paint shall be evened up by welding or with a suitable composite adherent material.

11.4. Evening up by welding shall be done in all cases before painting procedures.

11.5. Evening up by a suitable composite adherent material may be done after abrasive blasting or right after applying primer, but only with previous BUYER's approval.

11.6. The sharp edges, fillets, corners and edges of all miscellaneous steel items such as piping supports, angle bars, ladders, gratings, platforms, equipment foundations, electric boxes, wire ways, stations, handrails, bulwarks (internal and external surfaces), chocks, etc., shall have their edges and corners rounded and shall be rounded or smoothened before surface preparation and painting.

11.7. All sharp edges, fillets, corners and welds shall be rounded or smoothed by grinding (min. R2 mm) prior to blasting/coating.

11.7.1. If the SELLER has a coating system with edge retention more than 0.7, a three-pass grinding sharp edge preparation type 2C (see 5.2.1.1) may be used. If grinding disc finishing is leaves burr. A flap finishing disc shall be used. The Figure 19 present detail of this configuration.

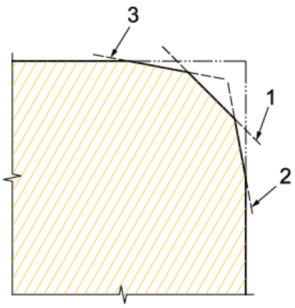

Figure 19 – Three-pass sharp edge preparation type 2C.

11.7.2. Before preparing the surface to be coated, a visual inspection of the entire surface shall be done to note points displaying vestiges of oil, grease or fat and the degree of corrosion affecting the surface (A, B, C or D, in accordance with Standard ISO 8501-1).

11.8. Steel material shall be inspected and shall not exceed maximum rust grade ISO8501-1 Grade C. Other materials shall also be inspected and shall not present any pitting.

12. SURFACE PREPARATION

12.1. REQUIREMENTS OF SURFACE PREPARATION

12.1.1. Carbon steel surface preparation shall be according to level Sa 2 ½ (ISO 8501-1) or WAB-2 (according to SSPC-VIS-5 / NACE VIS-9), with roughness profile of 50 - 100µm (ISO 8503-5), grade medium G (ISO 8503-2), unless otherwise stated at coating system.

12.1.2. Stainless steel surface preparation (including duplex, and superduplex material) shall be according to level Sa 2 ½ (ISO 8501-1) or WAB-2 (according to SSPC-VIS-5 / NACE VIS-9), with roughness profile of 30 - 85µm (ISO 8503-5), grade medium G (ISO 8503-2), unless otherwise stated at coating system.

12.1.2.1. Stainless steel surface preparation (including duplex, and superduplex material) is not required prior varnish application for preservation of uncoated surfaces.

12.1.3. CuNi surface preparation shall be according to SSPC SP 16, with roughness profile of 20-30µm (ISO 8503-5).

12.1.4. For any coating material, when manufacturer recommended roughness profile is above minimum value in the roughness range specified by BUYER, coating manufacturer recommended roughness shall be considered as minimum value.

12.1.5. Stainless steel, nickel, and copper-based alloys shall be cleaned with dedicated abrasive.

12.1.6. Abrasive used for HDG surface preparation cannot be used for stainless steel.

12.1.7. Halide-free detergents and potable water shall be used for pre-cleaning and rinsing of stainless steels and non-ferrous materials.

12.1.8. Aluminum surfaces requiring coating shall be de-greased using an alkaline, emulsifying detergent followed by rinsing with potable water and sweep blasting using non-ferrous abrasive in conformance to

SSPC SP 16. Emulsions and alkaline solutions for cleaning aluminum alloys shall have a pH not exceeding pH 9.

12.1.9. Surface preparation of Polymer Composites and thermoplastics

12.1.9.1. To remove contaminants, perform cleaning with isopropyl alcohol. Use detergent and water only if there are oils or greases.

12.1.9.2. Apply light sanding with sandpaper # 80 to # 120.

12.1.9.3. After sanding and removal of dust, perform again cleaning with isopropyl alcohol, heptane or hexane, leaving the surface clean and dry.

12.2. ABRASIVE BLASTING CLEANING

12.2.1. The abrasive blast cleaning may be dry or wet.

12.2.2. Vacuum blast cleaning equipment shall be foreseen when local restrictions or C&A stage does not allow open blasting.

12.2.3. Localized abrasive blast cleaning shall be preferred for field joints surface treatment.

12.2.4. Whenever is not feasible to perform abrasive blast cleaning in a specific design configuration, SELLER shall submit BUYER evaluation a request for power tool cleaning to bare metal in accordance with SSPC-SP 11. The execution of power tool shall be witnesses by the BUYER.

12.2.5. Abrasive blasting shall not be executed when:

a) Substrate surface temperature is less than 3°C above dew point.

b) Substrate surface temperature is higher than 52°C.

c) Relative humidity higher than 85%.

12.2.6. The compressed air supply used for abrasive blasting shall be free of water and oil. The compressed air pressure in the equipment shall be sufficient to achieve the surface preparation standard and the roughness profile established in the design.

12.2.7. All welding shall be abrasive blasted. Field welding power tooling (SP11) shall be agreed between SELLER and BUYER.

12.2.8. Any work concerned to blasting and coating shall only be carried out after completion of all hot works at the region, and its approval.

12.2.9. All drains/scuppers shall be plugged during blasting and painting works.

12.2.10. Flanges and connections surfaces shall be protected from surface preparation. The protection shall cover the region of the flange gasket / seal ring. Sacrifice anodes installed in tanks should also be protected.

12.2.11. Anodes installation in sea chests, longitudinal bulkheads, transversal bulkheads, web frames

and longitudinal shall be performed before blasting and painting works. The new anodes must be protected during coating and blasting jobs, and protection must be removed after these job conclusions.

12.2.12. By the end of the blasting works in each confined space, it shall be cleaned. Grit shall be removed and sent ashore. This job must be performed to BUYER representative satisfaction.

12.2.13. The surface preparation and painting application shall be executed with a minimum illumination value E (lux) of 750 in accordance with NHO 11.

12.2.14. Before beginning any blasting jobs on internal surfaces of confined spaces like tanks, voids, cofferdams, covered area etc., ventilation, heating and dehumidification equipment shall be arranged and used by SELLER to maintain a maximum relative humidity.

12.2.15. The environmental control of steel tanks, vessels and other enclosed spaces shall follow the requirements of SSPC TR 3/ NACE 6A192. In case of conflict between the requirements of SSPC TR 3/NACE 6A192 and this Technical Specification, the technical specification's requirements take precedence.

12.2.16. If wet blasting is performed, water used shall be clean, fresh, free from contaminants (e.g. Fe), with a pH between 6.5 and 7.5 and with a concentration of chloride below 40 ppm.

12.3. POWER TOOL CLEANING

12.3.1. SSPC SP11 with roughness profile of at least 50 microns is the only power tool method accepted.

12.3.2. Field welding power tool (SP11) shall only be applied when blasting is not feasible and shall be agreed between SELLER and BUYER.

12.3.3. Power tools used to clean carbon steel shall not be re-used on stainless steel, nickel and copper-based alloys. Power tools used to clean stainless steel, nickel, and copper based alloys shall be made of corrosion resistant material, stainless steel as a minimum.

12.4. HYDRO-BLASTING

12.4.1. In case of secondary surface preparation, WJ2 (NACE WJ-2) may be used if the primary surface preparation roughness is in accordance with the specific coating system (see annex A) and no corrosion is visible. The roughness profile criteria shall be the same as for abrasive blasting. Hydro-blasting (or Ultra Hight Pressure Water-blasting) shall be made with water pressure from 30000 to 55000 psi (2068 to 3792 bar).

12.4.2. When preexisting surface profile is not suited to provide a good anchor pattern or profile, an Abrasive Air Blast-cleaning, Abrasive Waterjetting (AB-WJ) or Ultra High Pressure Abrasive Blasting (UHP-AB) shall be done.

12.4.3. The high-pressure water washing shall be performed at a minimum pressure of 3000 psi. The surface shall be painted before rust bloom occurs.

12.4.4. Before proceeding to hydroblasting, shall be evaluated whether the roughness profile pre-existent is adequate. During work, the roughness profile shall be periodically checked after the water jet.

12.4.5. The use of Abrasive Hydroblasting (AB-WJ) grade WJ2 according to NACE SSPC-SP12 shall be considered for damaged or corroded areas or when the required anchoring profile cannot be achieved using only hydroblasting.

12.4.6. The hydroblasting shall not be the sole treatment of welding joints, since does not provide a minimum 50 µm roughness profile.

12.4.7. The water used in hydroblasting operations shall be clean, fresh and free of contaminants (e.g., iron), with a neutral pH and a chlorine concentration below 40 ppm and shall contain a flash rust inhibitor.

12.4.8. The flash rust inhibitor shall be a liquid, alkaline, water-soluble chemical capable of preventing the formation of flash rust corrosion on exposed carbon steel for at least 24 hours.

12.4.9. The product shall not contain a surfactant or any additive that promotes degreasing and that may require rinsing after application.

12.4.10. The flash rust inhibitor shall be pre-qualified in accordance with the requirements stated Table 19 at in certified laboratories which have a quality system in compliance with ISO 17025 or equivalent. The laboratories shall be accredited by the international Accreditation Forum (IAF) or INMETRO.

Table 19 – Laboratory test – flash rust inhibitor

Tests	Requirements		Standards to be used
	Min.	Max	
Visual pattern	72hrs		temporary protectant to preserve the visual pattern of the surface preparation for at least 72 hours in a CX environment (ISO 12944-2).
Compatibility with coating systems			Same as coating system, but surface preparation shall be WJ-2/ WAB-2 with flash rust inhibitor.
pH of the solution diluted with fresh water at 3% (v/v)	8	10	
Content of soluble salts after surface preparation (µg/cm^2)		7	
Immersion of exposed carbon steel coupons in fresh water with either inhibitor or without inhibitor (prepared specimens).	48hrs		No corrosion on sample immersed in inhibitor solution

12.4.11. The use of hydro blasting as a surface preparation (even secondary surface preparation) for bottom of structural tanks handling oil, such as CARGO TANKS is forbidden.

13. COATING APPLICATION

13.1. COATING APLICATION REQUIREMENTS

13.1.1. Prior to coat application the metallic surface shall be free of oil or grease contamination. If necessary, shall be cleaned in accordance with SSPC SP 1.

13.1.2. Before application of each coat of paint, all surfaces shall be cleaned off by a hairbrush or broom, by air blast or by a damp rag, so as to remove dust, salts and/or other contaminants.

13.1.2.1. Surfaces that have been machined and other surfaces that are not to be painted shall be

covered with a coat of removable varnish.

13.1.3. For each coat, a stripe coat shall be applied by brush to all welds, corners, angles, edges, holes and other areas not fully reachable by spray in order to obtain the specified coverage and thickness.

13.1.4. The stripe coat shall extend a minimum of one inch (3 cm) from the edge, on both sides.

13.1.5. Each subsequent coat, including stripe coat, shall have a contrasting color in order to provide confidence in coverage.

13.1.6. The recommended thicknesses are those indicated under the specific conditions for each equipment, piping or structure.

13.1.7. Wet on wet application is acceptable in order to reduce the number of coats of same paint. In this case, the dry film thickness shall be the sum of the coats specified.

13.1.8. The applicator shall check the wet film thickness of individual coat during application against the product data sheet according to ISO 2808 Method 1A or ASTM D4414.

13.1.9. All areas with insufficient thicknesses of paint or other application defects shall be repainted. The next coat shall be applied just after a complete drying of paints in the repaired areas.

13.1.10. Time intervals (maximum and minimum) between coats shall be specific for each painting set-up for the respective equipment, piping or structure. The PDS shall contain those data.

13.1.11. On equipment or piping to be connected by welding, the region between 5 cm after and 5 cm forward from welded connection shall be left unpainted, in order to receive surface preparation and primer paint after welding and testing.

13.1.12. Weld joints of piping system may be painted before hydrostatic test. The procedure for this execution shall be defined during detailing phase in conjunction with BUYER.

13.1.13. Equipment and piping with internal coating shall be hydrostatically tested prior coating application.

13.1.14. Equipment or piping painted before assembly shall not be handled until all paints have dried. Handling of this equipment or piping shall be performed in order to minimize damage to the paint job. This procedure shall include the use of steel cables suitably protected or fabric belting in the case of small parts.

13.1.15. Surface preparation in the vicinity of a “recently” painted surface shall be performed only when the paint is dry to the touch.

13.1.16. Equipment, piping or structural parts that have been painted but not yet assembled shall comply with following storage requirements:

a) To be kept apart from one another.

b) Not to be in contact with the ground.

c) To be positioned so as to keep down, as much as possible, the number of points exposed to build-

up of rainwater or earth, or to contamination or deterioration of the paint.

13.1.17. Any paint used by the SELLER for plate and stiffener marking shall be compatible with the subsequent painting scheme. It is not allowed to use chalk and oil pencil.

13.2. PAINT PREPARATION

13.2.1. Every paint shall be homogenized before and during application so as to keep the pigment suspended. Paints comprised of 2 or more components; they shall be separately homogenized before mixing. After mixing, no streaks or strips of different colors shall be observed, and the appearance shall be uniform.

13.2.2. Homogenization shall occur in the original container, and the paint shall not be removed from it before all the settled pigment has been incorporated into the vehicle. However, part of the paint not sediment may be temporarily removed to facilitate the homogenizing process. If difficulties arise in the dispersion of the settled pigment, the paint shall not be used.

13.2.3. The homogenization process for zinc-rich paints shall be carried out using a mechanical agitator to keep it in suspension so that the zinc powder does not settle to the bottom of the paint container.

13.2.4. The use of air flow beneath the paint surface in order to mix or homogenize it is not permitted under any circumstances whatsoever.

13.2.5. In the case of curdling, skinning or thickening in a recently opened can, the paint shall be rejected.

13.2.6. When paint dilution actually proves to be necessary, the thinner specified by the paint manufacturer shall be used. The maximum percentage of thinner specified in the technical bulletin of the product, based on the application method to be used, and shall not be exceeded.

13.2.7. The thinner shall be incorporated into the paint during the process of mixing and homogenization. Painters shall not add thinner to the paint after it has been diluted to the proper consistency.

13.2.8. Drying compounds shall not be added to paints.

13.3. APPLICATION PROCESS

13.3.1. Brush

13.3.1.1. Brushes shall be used for painting welded areas, irregular surfaces, bolt holes, sharp corners and cavities, except in case of inorganic silicate base paints.

13.3.2. Roller

13.3.2.1. In no circumstance the use of roller shall be accepted to apply primer coat and zinc rich primer.

13.3.2.2. Rollers shall be used for painting extensive flat, cylindrical and spherical areas of considerable radius of curvature, except where inorganic silicate base paints are being used.

13.3.2.3. Two (2) adjacent strips of the same coat of paint shall be overlapped a minimum of 5 cm.

13.3.2.4. Roller application shall not be used on irregular surfaces as rivets, bolts, crevices, welds, corners or edges, unless otherwise specified in the painting procedure.

13.3.3. Conventional Spray Gun

13.3.3.1. The compressed air used in the spray gun shall be free from water or oil. The compressed air control shall be done according to ASTM D4285.

13.3.4. Airless Spray Gun

13.3.4.1. The airless spray gun shall always be used where practicable, being the preferred method of application.

13.3.4.2. Inorganic zinc primers shall be applied using the airless spray gun with painting equipment with mechanical agitation during application. Other application process requires prior BUYER approval.

13.3.4.3. The specified distance range for standoff distance by the PAINT MANUFACTURER shall be followed during the paint application.

13.4. ENVIRONMENTAL CONDITIONS DURING COATING APLICATION

13.4.1. Paint shall not be applied to metallic surfaces when any of the conditions below applies:

a) Substrate surface temperature is less than 3°C above dew point.

b) Substrate surface temperature is lower than 5ºC.

c) Substrate surface temperature is higher than 52°C.

d) For solvent-base inorganic zinc rich paint, the temperature of the metal surface shall not exceed 40ºC.

13.4.2. Coating shall be applied and cured at temperatures and relative humidity within the limits specified in the coating manufacturer product data sheet.

13.4.3. The coating systems shall be suitable for curing at the environmental conditions of the shipyard in all seasons.

13.4.4. For traditional epoxy/polyamide coatings, substrate surface temperature shall be higher than 10ºC.

13.4.5. The exception is the case of paints which drying takes place exclusively by evaporation of solvents; such paints may be applied provided the temperature is not lower than 2°C.

13.4.6. No paint shall be applied if there are expectations that the ambient temperature is going to fall below minimum specified by manufacturer before the paint has had time to dry. Temperate shall be sustained at a minimum until paint is cured.

13.4.7. No paint shall be applied when the wind velocity is such that dust and dirt may be deposited on

the wet paint film, or it will interfere with any spray paint application being performed, the paint application shall be stopped.

13.4.8. No paint shall be applied in rainy, misty or foggy weather, or when there are expectations that the latter condition will be attained.

13.4.9. Solvent-base inorganic zinc rich paint shall be applied when relative humidity is between 60% and 85%.

13.4.10. The environmental conditions shall be regularly measured according to standard ISO 8502.

13.4.11. Before beginning any painting jobs on internal surfaces of confined spaces like tanks, voids, cofferdams, etc., ventilation, heating and dehumidification equipment shall be arranged and used by SELLER, in order to maintain a maximum relative humidity.

13.4.12. The environmental control of steel tanks, vessels and other enclosed spaces shall follow the requirements of SSPC TR 3/ NACE 6A192. In case of conflict between the requirements of SSPC TR 3/NACE 6A192 and this Technical Specification, the technical specification's requirements take precedence.

14. INSPECTION & TESTING

14.1. GENERAL

14.1.1. Before the beginning of the work at C&A sites, piping internal coating facilities and pressure vessel internal coating facilities, a kick-off meeting shall be held with the attendance of BUYER, SELLER, Paint Manufacturer and Subcontractors (including third party coating applicator, when the case). This meeting shall detail:

a) The Quality Control Plan (QCP) and its requirements.

b) The coating systems.

c) Coatings procedures.

d) Inspection and checks to be performed according QCP.

e) Reports needed by QCP.

f) Procedure qualification and piping list (piping internal coating).

g) Pressure vessel internal coating surface preparation and painting area division and sequency of steps.

14.1.2. The PAINT MANUFACTURER shall supply ample and continuous survey of the surface preparation, paint and protective layer application.

14.1.3. All surfaces shall be surveyed by SELLER's Quality Control Representative, Paint Manufacturer Supervisor and BUYER inspectors before the painting starts, between the coating and after the end. To allow these surveys the SELLER shall provide safe conditions and suitable light for all treated or painted parts.

14.1.4. In case of sampling, the total area considered shall be in same batch of coating execution.

14.1.5. For elastomeric coating, the COATING APPLICATOR must maintain a coating manufacturer painting inspector(s) at SELLERs working site to perform painters training, to evaluate surface preparation, to accompany coating application and to accompany coating field inspections. Any non-conformity regarding to painting scheme application shall be treated with support of coating manufacturer painting inspector.

14.2. TESTS DURING WORK EXECUTION

14.2.1. During the coating works execution and progress the inspections and tests listed in Table 21 shall be performed. The frequency, acceptance criteria and consequences shall be considered as minimum requirements. The minimum number of randomly taken measurements to be taken for verifying the dust, soluble salts and roughness on surfaces is given at Table 20.

Table 20- Sampling Plan for Dust, Soluble Salts Test and Roughness.

Area/ length of inspection area – m² or m¹	Minimum number of measurements		
	Dust test	Soluble salts test	Roughness
Up to 50	1	1	2
Above 50 to 100	2	1	3
Above 100 to 250	3	1	1 each 50 m², minimum 3
Above 250 to 1000	2 each 300 m²	1 each 300 m²	1 each 100 m²
Above 1000 m²	2 each 500 m²	1 each 500 m²	1 each 200 m²
NOTE (1): Adopted length only for piping. For other equipment adopted area.			

Table 21 - Inspection and Tests to be performed during Work Execution

Test Type	Method	Extent/Frequency	Acceptance criteria	Consequence
Environmental conditions	ISO 8502-4	Before start and end of each shift. [1]	See item 12.2.5 and 13.4	No blasting or coating.
Steel and welding imperfections	ISO 8501-3	100% of surfaces	No defects. See item 11.	Defects to be repaired
Pre-cleaning of surfaces	SSPC-SP 1	100% of surfaces	Free of oil and greases or other contaminants	Re-clean until acceptable
Oil and Grease contamination	ANNEX B	One test in each 250 m² or in any area suspected to have oil or grease contamination.	Free of oil and greases	Re-clean until acceptable
Compressed air	ASTM D4285	Before start and end of each shift	Free of oil and moisture	No blasting and coating
Abrasive material	ASTM D4940	Before start and end of each shift	<150 µS/cm	Materials discarded and clean abrasive. shall be used
Dust test	ISO 8502-3	See Table 20 and item 14.2.5	Quantity: rating 1 Dust size: 3 or over[2]	Re-clean until acceptable
Determination of water-soluble salts	ISO 8502-6 ISO 8502-9	See Table 20 and item 14.2.5	See Table 22	Re-clean until acceptable
Surface Preparation Grade	ISO 8501-1	100% of surface	According to specified requirements	Re-blast until acceptable
Roughness	NACE SP0287	See Table 20 and item 14.2.5	As specified in coating system	Re-blast until acceptable
DFT	ISO 19840	See item 14.3.2	ISO 19840	Repair, additional coats or re-coating as appropriate
Visual examination of coating	Visual to determine: - curing - contaminations -solvent retention -pinholes/ popping -sagging -surface defects	100% of surface after each coat and after exposure	According to specified requirements	Repair and re-testing

Note (1): Repeat the measurements during the course of the day, whenever environmental changes such as wind, fog and temperature drops occur.
(2) Lower dust size classes to be removed if visible on the surface to be coated without magnification

14.2.2. This number of tests shall be increased for inspection areas having a difficult configuration with regard to paint application or measurement or limitations in accessibility (difficult areas).

14.2.3. The measurements shall be done after surface preparation and before the paint application.

14.2.4. Consider the total area of each equipment or piping prepared during a work shift as the inspection area.

14.2.5. The first 5 batches of paint execution shall have an increase in frequency of about 100% over the frequency of the Table 20. In case of a systematic noncompliance with those tests, the frequency shall also be increased.

14.2.6. The roughness shall have an angular profile and shall be measured using replica tape (replica tape) according to ISO 8503-5 or using the "Stylus" method by ISO 8503-4, considering the parameter RZ DIN or Ry5. The total roughness shall be obtained by three random measurements on the surface.

14.2.7. The maximum acceptable water-soluble salts on abrasive blasted surfaces before paint application, measured according to ISO 8502 - Parts 2 to 6; 9;11; shall be according to Table 22.

Table 22 - Maximum Acceptable Water-Soluble Salts Contamination.

Surface material	Maximum acceptable water-soluble salts
Internal coating for piping (FBE) – in process	2 $\mu g/cm^2$
Internal coating	3 $\mu g/cm^2$
Stainless steel	3 $\mu g/cm^2$
Any other material's surface on Im2 /Im4 environment (1)	3 $\mu g/cm^2$
Any other material's surface on CX environment (1)	5 $\mu g/cm^2$
Note (1): Environmental classification according to Table 1.	

14.2.8. Water soluble testing is required for all surface preparation methods, including hydroblasting.

14.2.9. The dust test is required for blasting and power tool cleaning.

14.2.10. Each coat of paint shall be of uniform thickness, free from flaws such as porosity, runs, wrinkling, swelling up, cracking, blistering, pocking and impregnation of abrasive matter.

14.3. TESTS ON COMPLETION OF COATING WORKS

14.3.1. When the coating system application is completed and coating cured, the tests and inspections listed in Table 23 shall be performed.

Table 23- Inspection and Tests to be performed on Completion of Coating Works.

Test Type	Method	Extent/Frequency	Acceptance criteria	Consequence
Visual examination of coating	Visual	100% of surface	No sagging, contaminations, orange peel, cracking, blistering, rust, damages and any other defect	Repair and re-testing
Final DFT	ISO 19840	Table 24	See item 14.3.2	Repair, additional coats or re-coating as appropriate
Adhesion Pull-Off	ASTM D4541. See item 14.3.4	Table 25	As stated in coating system.	Coating to be rejected.
Adhesion Crosscut [1]	ASTM D3359	Table 25	As stated in coating system.	Coating to be rejected.
Holiday detection	NACE SP0188 or NACE TM0186	See item 14.3.5	No holidays	Repair and re-testing
Delta TG[2]	CAN/CSA Z245.20Subsec. 12.7 ASTM D3418 ISO11375-1	**Error! Reference source not found.**One per work shift limited to a work shift of 12 hours	5>ΔTg>-2	Coating to be rejected
Hardness shore D[3]	ASTM D2240	Per batch; 1 every 500m² up to 1000m² or larger lots 1 every 1000m², with a minimum of 2 tests.	120-80% performance qualification value	Coating to be rejected
Dimensional inspection[4]		All flanges14.3.6	Applicable ASME code	Repair.

Notes: (1) Applicable only to CS 8 - Coating System Nº 82
(2) Applicable to pipping internal coating (CS 17, CS 18 and CS 21)
(3) Applicable to elastomeric coatings (CS 23 and CS 24)
(4) Applicable to internal coating

14.3.2. Dry Film Thickness

14.3.2.1. The criterion of 90/10 is not applicable; only for ballast tanks and when required by IMO RESOLUTION MSC.215(82). For other cases, applies the criteria of ISO 19840. For 90/10 criteria uses the dry nominal film thickness.

14.3.2.2. The nominal dry film thickness is considered the average between the minimum total thickness and maximum total thickness.

14.3.2.3. As an alternative to the ISO 19840 measurement procedure see ANNEX C.

14.3.2.4. The 90/10 criteria mean:

a) Areas in which the reduction of thickness per coat is less than 10% are acceptable provided the affected area does not exceed 10% of the overall surface.

b) If the reduction in thickness per coat exceeds 10% but beyond the minimum total thickness, no additional coat shall be applied over the entire affected area. If the reduction in thickness per coat exceeds 10% and there are points with thicknesses below the minimum total thickness, then additional coat shall be applied over the entire affected area; except in the case of zinc ethyl silicate, which, in this case, shall be totally removed and a new coat shall be applied.

c) Areas where the dry nominal film thickness is higher than the maximum total thickness may be approved if the adhesion is higher than the minimum required. Apply the requirements of item 14.3.4.

14.3.2.5. Dry film thickness gauges shall be calibrated daily using certified calibration plates.

14.3.2.6. Surfaces to be tested shall be dry, clean and free of dry spray before measurements are made.

14.3.2.7. The minimum numbers of randomly taken measurements necessary for verifying the dry film thickness on inspection areas shall be according to the TABLE 1 of ISO 19840 with the modifications state at Table 24.

Table 24- Sampling Plan for Dry film Thickness.

Measurement unit		Minimum number of measurements	Maximum number of measurements allowed to be repeated
Pipelines (length: m)	Equipment or pieces (area: m^2)		
Up to 30		30	6
Above 30 to 100		1 measurement each1 m^2 or 30 measurements, whichever is greater	15% of the minimum number of measurements
Above 100(see note)		Add 10 for every additional 100 m^2 (equipment) or 100 m (pipelines)	20% of the minimum number of measurements
Note: equipment areas or pipelines length above 1000 shall be divided into smaller inspection areas.			

14.3.3. The following criterion of acceptance is applicable to paint films visually examined: sagging, swelling, wrinkling, cracking, blistering, cratering, impregnation with abrasive and/or foreign matter, peeling off, oxidation and/or corrosion inclusion of hairs, pores and smudges are not accepted.

14.3.4. Adhesion

14.3.4.1. The adhesion test is essentially a destructive test, so the painted surface area where test is done shall be repainted or retouched.

14.3.4.2. As an alternative to execution in the painted component, a production test coupon of same substrate material shall be produced with same parameters of surface preparation and coating application at the same time as the coating lot being representative. This coupon shall be a flat plate with minimum thickness of 2 mm. This shall be performed for piping with ϕ <6".

14.3.4.3. In case of any non-conformance during the coating application (e.g. environmental, DFT) the pull-oof testing shall be done in the painted component.

14.3.4.4. As an alternative to testing adhesion to the failure point, the tests may be interrupted when the minimum specified adhesion value is achieved. This method precludes the need to repair coatings damaged by the test. The adherent pull stubs can then be removed by heating (without damaging the coating system) to soften the adhesive.

14.3.4.5. Sampling shall be performed according to Table 25.

Table 25- Sampling Plan for Adhesion.

Area/ length of inspection area – m² or m¹	Minimum number of measurements	
	External coating	Internal / Imersion coating
Up to 250	1	3
Above 250 to 500	2	5
Above 500 to 1000	1 each 250 m², min of 3.	6
Above 1000 m²	1 each 500 m², min of 4	1 each 500 m², min of 6
NOTE (1): Adopted length only for piping. For other equipment adopted area.		

14.3.4.6. Each pull off adhesion test shall be done according to the instructions below:

a) The test shall be performed using pneumatic adhesion tensile testing instrument with an automatic centered pulling force, and carried out when the system is fully cured, method D - Equipment Type IV and Method E or Equipment Type V- with automatic actuation.

b) In the sample painted area, bond pull-stub to the coating surface with adhesive and allow it to cure thoroughly. When it cured, carry out the adhesion test. If the test result shows lack of adhesion, the test shall be repeated at two points diametrically opposite, 1 meter away from the point of the previous test.

c) If the other two tests display no lack of adhesion, the sample area is approved by the adhesion test. In this case the adjacent initially tested area shall be re-applied (a circle of 0.2 m radius centered where pull-stub was bonded), with the areas of the subsequent test areas being retouched.

d) If both of them display a lack of adhesion, the sample painted area failed in the adhesion test and must be entirely re-applied.

e) If one of the two tests (see item a) displays a lack of adhesion, another two points diametrically opposite the failed point test shall be tested. If one of the additional two tests displays a lack of adhesion, the sample painted area failed in the adhesion test and shall be entirely repainted.

f) If both adhesion tests mentioned in item d) display no lack of adhesion, the sample area is approved by the adhesion test. In this case the failed tested areas shall be re-applied (a circle of 0.2 m radius centered where pull-stub was bonded), with the areas of the subsequent test's areas being retouched.

14.3.4.7. The criteria for the value and type of failure are stated at each coating system, except that any type of failure is acceptable for adhesion values of 20MPa or higher.

14.3.4.8. Alternatively, to the value stated at each coating system, SELLER may propose to BUYER the use of a maximum reduction of 20% of value from a pull off test performed by independent laboratory in compliance with ISO 17025 or equivalent and certified by International Accreditation Forum (IAF) or INMETRO, but not less than 5Mpa.

14.3.4.9. The adhesion test shall be done on complete applied and fully cured coating system.

14.3.4.10. The adhesion test may be executed before the fully cured, provided that there is a prior agreement with the paint manufacturer. In this case, in case of failure, a retest may be executed after the complete cure.

14.3.5. Holiday detector

14.3.5.1. This test is applicable to all areas subjected to immersion and internal coating.

NOTE: For cargo tanks the lower area, including web frames shall be considered as immersion areas.

14.3.5.2. Wet sponge 67½ volt holiday detectors may be used for film thickness less than 500 µm. High voltage DC holiday detectors equipped with a flexible brush electrode and set to a suitable voltage shall be used for film thickness exceeding 500 µm. The test voltage for high voltage holiday detection shall be calculated by multiplying the minimum coating thickness (µm) specified by the coating system.

14.3.5.3. The definition from wet or dry test shall be based on the maximum DFT.

14.3.5.4. The test shall be done after the last coat finish paint.

14.3.5.5. The test shall cover 100% of surface area.

14.3.5.6. In case of internals assembly or mechanical handling of equipment, spool or tank with internal coating, a spot check by means of holiday testing may be performed to confirm the integrity of the coating.

14.3.6. The dimensional inspection shall evaluate the parallelism of flanges after coating, surface profile for each specific flange joints. The coating thickness, including stripe coating, shall not exceed half of the expected gap between flanges.

15. PAINTING REPAIRS

15.1. Field welding is not painting repair and shall follow all surface preparation steps foreseen in this technical specification.

15.2. Welding joints, burn damages in painted blocks and big areas field painting (e.g. field deck painting) shall not be considered as repair area. In these cases, the surface preparation/condition shall be in accordance with the original coating system requirement.

15.3. Adjoin damaged painted areas inside an imaginary circle of 0.2 m radius shall be considered as a damaged area according to Figure 20 for purposes of painting repairs.

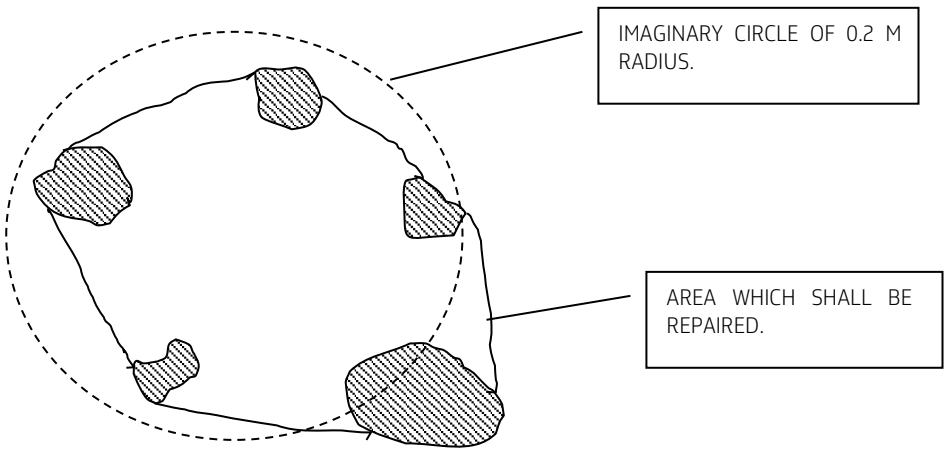

Figure 20 - How near damaged painted areas shall be considered.

15.4. All damage to previous coats shall be repaired before application of any subsequent coats.

15.5. Any repair and touch-up shall be performed according to the relevant surface preparation and coating system specified.

15.6. Feathering of the edges shall be done over a width of at least 50 mm.

15.7. All the steps of the repair and touch-up process shall be inspected and tested according to the contractual requirements.

15.8. In case of retouching on damaged paintwork, the original scheme shall be repeated, or the scheme defined during the qualification by the PAINT MANUFACTURER shall be used.

15.9. For damaged painted areas lower than one (0.5) m² an alternative option to the original surface preparation method may be SSPC SP 11 Power Tool Cleaning to Bare Metal.

15.10. Manual tool cleaning is not permitted.

15.11. In case of substrate did not expose the original paint, system shall be complemented with the minimum surface preparation by brush-off Sa 1 SSPC-SP 7.

15.12. For elastomeric coating the following requirements are applicable:

15.12.1. For damaged painted areas lower than one (1) m², a manual application of elastomeric coatings (PUR and PUA) with modified proprieties (e.g. pot life) may be applied. The coating manufacturer shall define the repair procedure specifically for each case.

15.12.2. For damaged painted areas above (1) m², the original scheme shall be applied, with application of elastomeric coatings by suitable spray device.

15.12.3. For internal coating of pipping, specific requirement applies. See 7.4.

16. SELLER DOCUMENTATION REQUIREMENTS

16.1. GENERAL

16.1.1. Procedures shall be developed based on the recommendations of the PAINT MANUFACTURER, the applicable Technical Standards, and best practices in the industry, the applicable law and in accordance with this specification.

16.1.2. The painting procedure shall be executed and approved by a painting inspector qualified, at least, by NACE International Coating Inspector Training and Certificate Program, level 3 or equivalent qualification (see I-ET-3010.00-1200-970-P4X-003).

16.1.3. Data sheets shall be provided in English and the language(s) of the country where the work is being performed.

16.1.4. This document requirements are also applicable to HDG coating.

16.1.5. The piping isometric and equipment general arrangement drawing shall state the designated coating systems. Detailing drawing shall indicate steel preparation required (e.g.: edge rounding radius, ground flush welding, P3 finishing).

16.2. COATING SYSTEMS SPECIFICATION AND COATING TECHNICAL FILE

16.2.1. A painting systems specification shall be issued for the project, stating for each coating system, applicable areas for application, requirements for surface preparation, trade brand of paints.

16.2.2. A coating system specification shall be issued for the project, correlating the coating system number with areas of application. The coating system shall indicate requirements for surface preparation, coat commercial name, color for each layer and dry film thickness.

16.2.3. This document shall present for all coating systems the performance documentation as stated at item 50.

16.2.4. During Paint Manufacturer BIDDING, the coating systems proposed shall follow Petrobras Coating System numbering and present:

g) Coating material commercial name

h) Color to be used for each coat

i) Thickness of each coat

j) Deviation analysis indicating where and when qualification protocol of the proposed paint system is not in full compliance with this technical specification.

k) Coating Technical File with all qualification testing reports the coating system proposed was analyzed.

l) Track Record (desired for all coating system, mandatory when indicated in Annex A).

16.3. QUALITY CONTROL PLAN

16.3.1. The Quality Control Plan is applicable for C&A sites and shall be issued by SELLER and be approved by BUYER, the Plan shall have at least:

a) List of applied codes, standards, technical specifications and procedures in item (b).

b) “Painting Inspection and Quality Standard” detailing all activities and acceptance criteria for painting.

c) Periodic reports about Coat inspection.

d) Site infrastructure and paint process overview from plates and beams receiving, primary surface preparation, steel preparation, secondary surface preparation, block stage, pre-erection stage, dock stage and quay stage.

e) List of coating subcontractor and its scope.

16.3.2. The organization chart of Manufacturer of equipment quality control team, clearly defining the responsibilities and authorities.

16.4. COATING PROCEDURE

16.4.1. C&A sites procedure shall indicate in its scope the site name, site location and scope (e.g. hull blocks, module number, module parts, etc).

16.4.2. VENDOR procedure shall indicate in its scope the equipment it is applicable to. For packages or when the equipment parts have different coating system, each component/part shall have a correspondent paint system.

16.4.3. VENDOR AND C&A procedures shall have a specific topic named "Deviation Management Analysis" where process, material, or practices not in full compliance with this technical requirement are indicated. For vendors, this items, if any, shall be discussed in the procurement periodic meetings. For C&A sites, these items, if any, shall be agreed and closed with BUYER.

16.4.4. A Procedure, by definition, is a specific and detail document. How to achieve the requirements brought by this technical shall be described, indicating material and equipment commercial name (e.g.: abrasive commercial name and grade; sand disc grade; infrastructure for temperature and humidity control, etc).

16.4.5. All coating procedure shall attach the coating inspection report template. All quality control items required in this technical specification shall be covered in the report template.

16.5. COATING EXECUTION PLAN

16.5.1. The Painting Execution Plan is applicable for C&A sites. It shall be issued before painting job starts and, as it serves as executes register, it shall be updated if any change in plan happens. The following data shall be detailed:

a) Primary surface preparation methodology and infrastructure.

b) Module/Hull Block division.

c) Secondary surface treatment methodology and infrastructure (e.g.: open blasting, cabin blasting).

d) Mechanical completion in secondary surface treatment stage (pre-erection of blocks foreseen, outfitting installation).

e) Number of coats applied after secondary surface treatment (block stage) for each part (e.g.: deck area, PFP, etc).

f) Surface preparation method for field welding and burn damage <0,5m2. -C&A stage and methodology for surface treatment and paint of decks and other areas >0,5m2.

g) Tank hull stage painting methodology.

h) Number of coats applied for piping before assembly.

16.5.2. Document shall contain a schedule for the painting considering all phases of construction and assembly.

16.5.3. All painting activities shall be fully incorporated in the assembly plan. Details concerning management, inspectors, operators, facilities, equipment and qualified procedures shall be established and documented before commencing work.

16.5.4. The SELLER shall plan the works to limit the amount of later field repairs.

16.5.5. The SELLER shall carry out "early outfitting" of every pre-fabricated structural section to ensure that all supports, and welds are completed prior to coating.

16.5.6. Any scaffold shall be supported by a wood or any suitable material to avoid damage to painted surfaces. The function of this material is to redistribute the pressure against a large area avoiding the direct contact between the steel tubulars to the painted surface.

16.5.7. Any hot work (like welding) which can damage the previous painted surface shall be planned before the painting works. When is not possible, the damaged area shall be reblasted and repainted.

16.6. WORK INSTRUCTIONS

16.6.1. Work instruction shall be issued at least for the following activities:

a) Preparation of welds, edges and other areas with surface imperfections.

b) Mixing of paints.

c) Hydroblasting.

d) Abrasive blasting.

e) Handling of painted components.

16.7. COATING INSPECTION AND TEST PLAN (ITP)

16.7.1. The painting ITP is applicable for C&A sites and Vendors. It shall state all steps of inspection and testing of painting. This document shall state the responsibilities for the SELLER; PAINT APLICATOR, PAINT MANUFACTURER, BUYER and CLASSIFICATION SOCIETY (when applicable) for each step.

16.7.2. In case of subcontractor, a painting ITP shall be issued and present the state the responsibilities for subcontractor, SELLER; PAINT APLICATOR AND PAINT MANUFACTURER. SELLER shall survey all work performed by subcontractors and perform inspection in accordance with ITP.

16.7.3. All painting steps shall be followed by a qualified painting inspector and shall be complemented by the corresponding painting and inspection reports for these steps.

16.7.4. The Inspector shall have the authority to inspect any material, tool and/or equipment used in the coating procedures and surface preparation operations. The Inspector shall have the right to condemn any and all material, work or equipment, which does not comply with this specification, including safety aspects.

16.7.5. The presence of BUYER Representative and his actions or non-actions connected with the quality control of the ongoing and/or finished work does not relieve and diminish the SELLER of its responsibility in respect of work execution.

16.8. COATING INSPECTION REPORT

16.8.1. Inspection reports according to requirements of Table 21 and Table 23 shall be issued.

16.8.2. Daily inspection reports shall be prepared and maintained by SELLER. This report, signed by Quality Control Representative and Paint Manufacturer's Supervisor, shall be handed over to BUYER for approval within 15 days of inspection execution date.

16.8.3. The reports shall indicate the items blasted and coated, surface preparation grade, roughness profile, dry layer thickness of each coating, adhesion level of finished coatings, holiday detector test voltage, materials used, including batch numbers, location, and outcome of inspections. Paint defect shall be reported using the nomenclature of ISO 4628-1 or ISO 28199. The reports shall also indicate ambient relative humidity, dew point temperature, air temperature, and steel surface temperature before starting paintwork and during the course of day.

16.8.4. For C&A sites the Coating Inspection Reports must represent and have traceability for the following stages:

a) Primary surface preparation: minimum roughness, shop primer specification, shop primer DFT, abrasive specification, salt test, relative humidity and temperature. Minimum frequency: one per week.

b) Secondary surface preparation: the block number shall be traceable to the report.

c) Erection Joints: erection joints shall be traceable to the report.

d) Erection: Deck area, Module elevation or section of it shall be traceable to the report.

16.8.5. For erection stage area inspection methodology shall be adopted.

16.8.6. For outfitting and spot repair, the inspection is by sampling but for each area, the surface preparation and each coat application shall be inspected by a qualified inspector.

16.9. PROCEDURE FOR INCOMING INSPECTION OF PAINTED PARTS

16.9.1. Vendor supply painted items shall have a receiving inspection at C&A site. As minimum, the receiving items shall have visual inspection and DFT inspection. Internally coated piping and equipment shall have a spot holiday test.

16.10. PROCEDURE FOR REPAIR OF COATED SURFACES

16.10.1. All coating system specified for C&A sites and Vendor equipment shall have a touch-up and maintenance paint procedure agreed between equipment designer and Coating Manufacturer. The procedure shall correlate surface preparation methods with recommended coating materials.

16.11. WARRANTY CERTIFICATE

16.11.1. In accordance with item 1818, a Coating Warranty shall be issued for the entire scope of SELLER.

16.12. FINAL COATING SURVEY

16.12.1. The objective of the final coating survey is to evaluate the coating condition and coating integrity of all areas of the UNIT.

16.12.2. The final coating survey shall be held between BUYER, SELLER and COATING MANUFACTURER after finishing the construction stage and before the sail away to final location, the integration in order to issue a report on painting conditions, and to elaborate a repair/corrective be issued by SELLER. The procedure shall MAINTENANCE PLAN.

16.12.3. Each C&A site shall bring to integration stage a coating punch list detailing the carry-over (if any) brough to integration stage. This mapping may require a final inspection at C&A sites.

16.12.4. The final coating survey shall evaluate the existing condition of all items using the following ISO 4628 2 to parts 5.

16.12.5. The Final Coating Survey shall also report an assessment of:

a) Surface contamination – grinding particle impregnation to a coating system,

b) Mechanical / fabrication damage to the coating system but where bare metal is NOT exposed.

c) Sections where the specified coating system is incomplete.

d) Surfaces where the coating system has been damaged and “Bare Metal is visible and exposed atmospheric contamination and deterioration.

e) Areas where modifications have been carried out after initial coating system has been applied and the additional steel has not received any surface preparation and mill scale is present on the substrate.

f) Areas that have been finish painted, and damaged during construction stage (Burn Damage, scratch, welding etc.)

g) Faulty craftsmanship (e.g., improper surface preparation, low dry film thickness, lack of stripe coat, etc.

16.12.6. The Final Coating Survey shall be formally reported, presenting at least, the area division, the inspection registers including area division and final inspection with photograph register and defects mapping.

16.13. MAINTENANCE PLAN

16.13.1. In order to comply with the COATING WARRANTY, a MAINTENANCE PLAN shall be issued by SELLER and approved by BUYER. This plan is intended to develop painting recommendations for future maintenance planning needs, in accordance with the Coating Warranty Document and aims to mitigate the threat of corrosion and maintain the overall appearance of FPSO floating facility. The MAINTENANCE PLAN shall consider predictive, preventive and corrective actions.

16.13.2. The MAINTENANCE PLAN shall cover onboard repair methods, such as surface preparation and material specification, and also shall serve as a manual for preventive practices to avoid premature failure and treat weaknesses identified during construction stage.

16.13.3. The Maintenance Plan shall be elaborated by a painting inspector qualified, at least, by NACE International Coating Inspector Training and Certificate Program, level 3 or equivalent qualification (see I-ET-3010.00-1200-970-P4X-003).

16.13.4. The SELLER shall establish a Maintenance Plan Methodology, where the coating condition (Ri value) of each component or area is weighted on its critical or priority level, defined together with the BUYER. The prioritization for the MAINTENANCE PLAN shall be based on the analysis of the coating condition and critical level combination scenario.

16.13.5. The SELLER shall establish together with the BUYER a methodology to divide the plan into blocks or areas and where a block or area is scheduled for painting the entire block or area shall be repainted except for any items that may have been specifically excluded. The Plan Methodology shall be established at the beginning of contract.

16.13.6. The MAINTENANCE PLAN shall be composed by at least the following:

16.13.6.1. The final coating survey report, including an Inspection summary that allows the traceability of reports, areas and equipment evaluated, inspection results, coating condition classifications and maintenance priority.

16.13.6.2. The items (areas or blocks) shall be listed. For each item the following minimum data shall be provided: substrate type, surface area, coating type, deterioration (ISO 4628), service environment, temperature, accessibility and coating thickness and strategy recommendation (touchup, remove/replace or do nothing).

16.13.6.3. A pluriannual painting maintenance Schedule recommendation, established in accordance with the MAINTENANCE PLAN methodology previously approved.

16.13.6.4. Set of specifications and procedures for the maintenance of paint / coatings, including Paint materials that shall be used during the maintenance, Surface preparation and environmental controls, Labor materials and equipment to be used on coating system and maintenance coating systems specifications.

16.13.7. Based on data above, a minimum five-year plan must identify the surfaces to be painted each year, give the cost estimated for conducting the work, provide comprehensive specification for surface preparation and coating preparation.

16.13.8. In case of non-agreement between SELLER and BUYER the conditions specified during the construction phase shall prevail.

17. ENVIRONMENTAL AND SAFETY

17.1. Abrasive blasting operators shall be properly protected by means of full-length drill pants, long-sleeved jackets made of chrome leather slivers, and compressed air face mask for abrasive blasting operations.

17.2. Hydro-blasting operators shall be properly protected by means of full length wet pants, long sleeve wet jackets, wet gloves, boots and masks for wet blasting operation.

17.3. The slings used in abrasive blasting operations: operators shall know the capacity of the sling. Charts or tables which contain this information (generally are available from sling manufacturers) shall be available to operators. Under no circumstances a sling's rated capacity shall be exceeded.

17.4. In doing paint work, operators shall use a mask with a mechanical filter (to keep out dust), or, in case of working with toxic solvents, with a chemical filter (against gases).

17.5. A continuity detector shall not be used on days on which there is a risk of atmospheric discharges.

17.6. PAINT MANUFACTURER shall supply PDS and MSDS of each coating material intended to be use.

17.7. For works in areas with restricted ventilation or confined spaces, a ventilation system shall be provided which can prevent the vapor concentration exceeding 10% of the Lower Explosive Limit (LEL).

17.8. The anti-fouling paint shall not contain organotin compound tributylin (TBT) component in its formulation.

17.9. Disposal of residual materials (spent abrasives, coating materials, solvents, etc.) shall be done in accordance with normative rules, regulations and laws in force in the country where the coating works is performed.

17.10. Besides all requirements specified in this document, SELLER scope of work includes all materials and services related to the following activities:

a) Removal of refuse or abrasives.

b) Removal of sewage.

c) Oil and grease removal.

d) Dust and salt removal; and

e) Scraping of barnacles.

18. WARRANTY

18.1. OBJECTIVE

18.1.1. The aim of this item is to establish the minimum requirements to be followed by SELLER regarding the provision of the COATING WARRANTY for the UNIT. The coating systems shall have a durability (as per ISO 12944-1 definition) of 25 years with minimum maintenance repair, during the UNIT lifetime.

18.1.2. The COATING WARRANTY shall cover a period as state at Table 26.

Table 26 – Warranty Period

Area or coating type	Warranty period (years)
Atmospheric exposure (main deck, topside, weather decks, etc.)	5
Internal coating (tanks, compartments, etc.), external hull, multi-polymeric matrix coating, Thermal Spray Aluminum	10

18.1.3. This document presents the criteria to cover the UNIT as a whole which, be applied on coating warranty during construction and operation phase.

18.2. GENERAL REQUERIMENTS

18.2.1. The COATING WARRANTY shall cover the entire scope of coating of SELLER, including vendor equipment supplied by SELLER.

18.2.2. Starting date of the warranty is the day of UNIT sail away to final location.

18.2.3. SELLER shall be liable for:

18.2.3.1. Repairs, replacement and full re-coating of areas of coating failures/defects that reach the acceptance limits criteria as per item 18.5, or

18.2.3.2. Reimbursement of all repair costs (except those lists in item 17.3.9) of coating failures/defects that reach the acceptance limits criteria as per item 17.5 (Paint Failure).

18.2.4. The Maximum Liability for all approved repairs carried out during the Guarantee Periods shall not exceed two (2) times the total invoice value of all Paint Materials supplied.

18.2.5. SELLER's warranty shall cover the entire coating process against any form of faulty craftsmanship.

18.2.6. SELLER shall repair any coating failure due to faulty craftsmanship (e.g., improper surface preparation, low dry film thickness, lack of stripe coat, etc.) identified on Final Coating Survey, as per item 16.2

18.2.7. The SELLER shall guarantee that paint supply is out of any faulty or errors in recommendation of the application. The paint manufacturer shall guarantee that the products supplied are suitable for the intended uses and are fully compliant with the product's technical specifications.

18.2.8. The SELLER shall warrant that the Coating System proposed by them meets or exceed the contractual requirements.

18.2.9. The warranty terms and conditions shall be commonly agreed between BUYER and SELLER and endorsed by the paint manufacturer. Excluded areas shall be mutually agreed and clearly recorded.

18.2.10. Each equipment, tank, structure (as riser balcony, mooring balcony, etc.) or pipeline system shall be considered as one for evaluating the coating failures.

18.2.11. The COATING WARRANTY shall define at least the items below:

a) Areas to be covered by COATING WARRANTY and Exceptions.
b) Warranty starts.
c) Cost of casual repair (m2) considering at least material and manpower.
d) Evaluation criteria for coated surfaces with flaw.
e) Definition of the reference areas in accordance with ISO 12944 Parts 7 and 8.
f) Coating System specifications.
g) Maintenance Plan.
h) Warranty period.
i) Rights and Responsibilities.
j) Other relevant aspects related to COATING WARRANTY but not listed above.

18.2.12. Reference areas shall be used to establish the minimum acceptance standard. Besides being monitored in periodic inspections, it will not be used as area failure criteria for warranty purpose, in this case each individual system/area/compartment/etc. will be considered.

18.3. RIGHTS AND RESPONSIBILITIES

18.3.1. Every failure in the coating system has to be repaired timely.

18.3.2. When repairs are made by SELLER, he will supply labor, materials and equipment to reapply the coating system in the same manner specified in the contract or according with the maintenance plan.

18.3.3. The BUYER is responsible for monitoring the coating systems repairs during the warranty period and will provide written reports to the SELLER of conditions related to warranty performance criteria.

18.3.4. The BUYER is responsible to notify the SELLER by written form of any necessary warranty work.

18.3.5. The BUYER reserves the right to approve the date(s), materials and methods requested by the SELLER to perform warranty work if any change from maintenance plan occur.

18.3.6. The BUYER has the right to require the SELLER to make immediate emergency repairs to prevent unsafe conditions. If the SELLER fails to complete repairs, the BUYER reserves the right to complete the repairs. This does not relieve the SELLER from meeting the warranty requirements.

18.3.7. The BUYER shall document the condition of the coating systems prior to any emergency repair.

18.3.8. The BUYER is responsible to provide scaffolding, rope access, facilities and for the transportation of the repair materials to the UNIT subject to coating repair.

18.3.9. For atmospheric exposed areas (main deck, topside, weather decks, etc., except external hull) BUYER shall be responsible for issuing periodic painting inspection reports (minimum one every eighteen (18) months) during the warranty period.

18.3.10. For all structural tanks (such as, cargo oil, ballast tanks, etc.), compartments (such as void spaces, and cofferdams, etc.) and for external hull, coating inspection shall follow Classification Society approved inspection plan.

18.4. EXCLUSIONS

18.4.1. Damage of fortuitous or accidental nature, such as substrate deformations, impacts, friction, leaks, run-outs, abnormal temperature rises, etc. are excluded from the Warranty Coverage after of acceptance of the UNIT by BUYER.

18.4.2. Changes in the intended use of the work, or the modification of the design parameters used as a basis for job approval, for example, operation with other fluids than the ones specified in the design are excluded from the Warrant coverage of acceptance of the UNIT by BUYER.

18.4.3. Occurrence of deteriorations in areas where design considerations of the substrate do not comply with accessibility requirements of ISO 12944-3.

18.5. PAINT FAILURE

18.5.1. Unless otherwise stated by the contract between BUYER and SELLER, coating system failure means: Rusting, according to ISO 4628-3; Blistering, according to ISO 4628-2, (refer to table 48); Cracking, according to ISO 4628-4, depending on the defect types b and c; Flaking, according to ISO 4628-5, depending on the defect types a and b; Wearing, loss of dry film thickness due to erosion or chalking.

18.5.2. Any paint defect or poor workmanship identified before sail away (including final coating survey) shall be repaired by SELLER.

Table 27 - Failure criteria

Coating type or area	Time (months)	Failure criteria					Maximum failure per area[1]
		ISO 4628-3 rusting	ISO 4628-2 blistering	ISO 4628-4 cracking	ISO 4628-5 flaking	Wearing loss of thickness	
Topside	0-60	Ri1	1(S2)	1(S2) b	1(S2) a	10%	3%
Tanks, hull bwl, bootop	0-60	Ri1	1(S2)	1(S2) b	1(S2) a	10%	1%
	61-120	Ri2	2(s2)	1(S3) b	1(S2) a	10%	3%
TSA	0-180	Ri1	0	0	0	0	3%
CUI coating	0-120	Ri1	0	1(S2)	1(S2) a	10%	3%
Note 1: Maximum failure per area: percentage of the considered area (as per area division agreed on maintenance plan) over which the warranty repairs shall be claimed.							

ANNEX A - COATING SYSTEMS

CS 1 - Coating System Nº 1

Coating System Nº 1			
Intended uses	FPSO underwater zone and niche area Lower Riser Balcony Underwater Caisson (external/ internal)		
Environment corrosivity	Im4	Substrate Materials	Carbon steel
Minimum/maximum operating temperature		-50°C to 50°C	
SURFACE PREPARATION			
Standard/Grade		Sa 2 ½ / WAB-2	
Roughness		50 to 100 µm	
Water Soluble Salts		3 µg/cm²	
Steel preparation		ISO 8501-3 – Grade P3	
COATING SYSTEM[6]			
Coat	Type of coat / binder		min DFT, µm[1]
Primer	Glass flake or Fiber reinforced epoxy		500
2º coat	Tie coat[2]		80
Topcoat	Antifouling[3]		300
Total min DFT			880
PERFORMANCE TEST[4]			
Table 2		1; 3; 4; 5; 6.	
Track Record		Required[3]	
INSPECTION AND TESTING[7]			
Tests during work execution		Table 21	
Final visual		100% examination of coating	
Adhesion		10MPa (except failure type A/B, after 2° coat)	
Final DFT		See item 14.3.2	
Holiday detection		100% after 1° coat	
Repair system		Original coating systems	

NOTES:
\1\ Maximum DFT shall be as per Paint Manufacturer.
\2\ If required by PAINT MANUFACTURER. See item 5.2.8.7
\3\ See requirements at item 5.2.8.

CS 2 -Coating System Nº 2

Coating System Nº 2			
Intended uses	Topside structures Structure below lowest grating and foundations at engine room, Accommodation block (outer surface), Local Equipment Rooms + Laboratory. Lay down area, Central Pipe Rack, Steel Structures Uninsulated or with perforated guards / metallic mesh equipment and piping HVAC Duct located atmospheric exposure		
Environment corrosivity	CX	Substrate Materials	Carbon steel
Minimum/maximum operating temperature	-50°C to 80°C		
SURFACE PREPARATION			
Standard/Grade	Sa 2 ½		
Roughness	50 to 100 µm		
Water Soluble Salts	5 µg/cm²		
Steel preparation	ISO 8501-3 – Grade P3		
COATING SYSTEM			
Coat	Type of coat / binder		Nominal DFT, µm
Primer	Zinc Rich Epoxy Primer²		100
2° Coat	Polyurethane (water repellent), Polysiloxane, Fluoropolymer or Polyaspartic²	Epoxy	150
Topcoat³		Polyurethane	70
Total min DFT			300
PERFORMANCE TEST⁴			
Table 2	1; 2		
INSPECTION AND TESTING			
Tests during work execution	Table 21		
Final visual	100% examination of coating		
Adhesion	5MPa (permitted failure type B and B/C)		
Final DFT	See item 14.3.2		
Repair system²	As defined by PAINT MANUFACTURER: min 300 DFT if with zinc rich primer min 400 DFT if based in only barrier (e.g. epoxy based).		

NOTES:
\1\ May be applied in one or two or coats.
\2\ Mandatory performance test data on repair system and track record.

CS 3 - Coating System Nº 3

Coating System Nº 3			
Intended uses	Hull topside, Deck area, Lifeboat Platforms & Davits, Offloading Platform, Chain Lockers, Steel caisson (above splash zone) Deck / Skid Floor Structures of Process Modules		
Environment corrosivity	CX	Substrate Materials	Carbon steel
Minimum/maximum operating temperature		-50°C to 80°C	
SURFACE PREPARATION			
Standard/Grade		Sa 2 ½ / WAB-2	
Roughness		50 to 100 µm	
Water Soluble Salts		5 µg/cm²	
Steel preparation		ISO 8501-3 – Grade P3	
COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[1]
Primer [2]	Epoxy Glass Flake		500
Topcoat[3]	Polyurethane, Polysiloxane, Fluoropolymer		70
Total min DFT			570
PERFORMANCE TEST[3]			
Table 2		1; 2; 3, 5; 6.	
INSPECTION AND TESTING			
Tests during work execution		Table 21	
Final visual		100% examination of coating	
Adhesion		7MPa (except failure type A/B)	
Final DFT		See item 14.3.2	
Repair system		Original coating systems	

NOTES:
\1\ Maximum DFT shall be as per Paint Manufacturer.
\2\ May be applied in one or two coats.
\3\ For deck area, topcoat may be waived.

CS 4 - Coating System Nº 4

Coating System Nº 4			
Intended uses	Carbon steel uninsulated or with perforated guards / metallic mesh equipment, piping and supports at 80ºC≤T<200ºC. Valves (insulated/ uninsulated) up to 200°C. SS uninsulated or with perforated guards / metallic mesh equipment, piping and supports between -50 and 200°C coated. SS topside structures coated.		
Environment corrosivity	CX	Substrate Materials	Carbon steel Stainless steel
Minimum/maximum operating temperature		-50°C[1] to 200°C	
SURFACE PREPARATION			
Standard/Grade		Sa 2 ½	
Roughness		50 to 100 µm - carbon steel	30 to 85 µm - stainless steel
Water Soluble Salts		5 µg/cm² - carbon steel	3 µg/cm² - stainless steel
Steel preparation		ISO 8501-3 – Grade P3	
COATING SYSTEM			
Coat	Type of coat / binder		min DFT[2], µm
Primer	Epoxy novolac (Alkylated Amine Epoxy)		125
Topcoat	Epoxy novolac (Alkylated Amine Epoxy)		125
Total min DFT			250
PERFORMANCE TEST			
Table 2		1; 2	
INSPECTION AND TESTING			
Tests during work execution		Table 21	
Final visual		100% examination of coating	
Adhesion		12MPa (except failure type A/B)	
Final DFT		See item 14.3.2	
Repair system		Original coating systems	

NOTES:
\1\ For temperatures below -50°C the PAINT MANUCTURER shall present documented testing or field experience relevant to the specific intended use.
\2\ Maximum DFT shall be as per Paint Manufacturer.

CS 5 - Coating System Nº 5

Coating System Nº 5			
Intended uses	Outfitting (Carbon steel Cage Ladders, Handrail, Guardrails), Carbon steel grating at critical areas. Carbon steel piping supports T≤80°C. HVAC HDG ducts, Telecom Tower (HDG), HDG Equipment and piping		
Environment corrosivity	CX	Substrate Materials	HDG
Minimum/maximum operating temperature	-50°C to 80°C		
SURFACE PREPARATION			
Standard/Grade	Sweep blasting according SSPC-SP 16.		
Roughness	20 - 30µm		
Water Soluble Salts	5 µg/cm²		
Steel preparation	ISO 8501-3 – Grade P3		
COATING SYSTEM[1]			
Coat	Type of coat / binder		min DFT, µm²
Primer	Epoxy		150
Topcoat	Polyurethane		75
Total min DFT			225
PERFORMANCE TEST			
Not applicable			
INSPECTION AND TESTING			
Tests during work execution	Table 21		
Final visual	100% examination of coating		
Adhesion	7MPa (permitted failure type B/C)		
Final DFT	See item 14.3.2		
Repair system	See item 8.3.2 and 8.3.3		

NOTES:
\1\ See item 8.3.1.1 and 8.3.1.2.
\2\ Maximum DFT shall be as per Paint Manufacturer.

CS 6 - Coating System Nº 6

Coating System Nº 6			
Intended uses	Engine Room/ Pump Room, Walls and ceilings, Covered floors and uncovered floors of HVAC / Controlled Rooms[4,5] HVAC duct located at controlled room. Void Spaces & Cofferdams Sea water lift pump		
Environment corrosivity	CX	Substrate Materials	Carbon steel and stainless steel
Minimum/maximum operating temperature	-50°C to 80°C		
SURFACE PREPARATION			
Standard/Grade	Sa 2 ½ / WAB-2		
Roughness	50 to 100 µm - carbon steel	30 to 85 µm - stainless steel	
Water Soluble Salts	5 µg/cm² - carbon steel	3 µg/cm² - stainless steel	
Steel preparation	ISO 8501-3 – Grade P3		
COATING SYSTEM			
Coat	Type of coat / binder	min DFT, µm[1]	
Primer[2]	Epoxy[3]	150	
Topcoat[2]	Epoxy[3]	150	
Total min DFT		300	
PERFORMANCE TEST			
Table 2	1; 2		
INSPECTION AND TESTING			
Tests during work execution	Table 21		
Final visual	100% examination of coating		
Adhesion	10MPa (except failure type A/B)		
Final DFT	See item 14.3.2		
Repair system	As defined by PAINT MANUFACTURER; min 300 DFT.		

NOTES:

\1\ Maximum DFT shall be as per Paint Manufacturer.

\2\ May be applied in one or two coats.

\3\ Epoxy with direct to metal propriety (DTM).

\4\ Covered material in floor or wall may also act as a corrosion protection system. Where is applied Primary Deck Covering, covering manufacturer instructions shall be followed.

\5\ For covered walls only the primer coat is required.

CS 7 - Coating System Nº 71

Coating System Nº 7			
Intended uses	Uninsulated equipment, piping and supports with T>200°C, or in vapor service. Crane boom, Mooring Hawser Winch, Hose Reel Insulated equipment, piping valves and supports of stainless steel. Topside structures >200°C, Flare Tower and Vent Post		
Environment corrosivity	CX	Substrate Materials	Carbon steel and stainless steel
Minimum/maximum operating temperature		-50°C to 600°C	
SURFACE PREPARATION			
Standard/Grade		Sa 3	
Roughness		50 to 100 µm - carbon steel	30 to 85 µm - stainless steel
Water Soluble Salts		3 µg/cm²	
Steel preparation		ISO 8501-3 – Grade P3	
COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm
Primer	TSA[1]		200
Topcoat[2]	Sealer		-
Total min DFT			200
PERFORMANCE TEST			
Not applicable			
INSPECTION AND TESTING			
Tests during work execution		Note 1	
Final visual		100% examination of coating	
Adhesion		7MPa	
Final DFT		Note 1	
Repair system		Note 1	

NOTES:
\1\ For TSA see I-ET-3010.00-1200-956-P4X-003.
\2\ In case of color coding requirement, a topcoat of Polyurethane may be applied with a maximum of 70 µm DFT.

CS 8 - Coating System Nº 82

Coating System Nº 8			
Intended uses	Insulated equipment and piping of carbon steel Insulated carbon steel valves at T>200°C		
Environment corrosivity	CUI-2; CUI-3	Substrate Materials	Carbon steel
Minimum/maximum operating temperature		-50°C to 650°C	
SURFACE PREPARATION			
Standard/Grade		Sa 2 ½ / WAB-2	
Roughness		50 to 100 µm	
Water Soluble Salts		5 µg/cm²	
Steel preparation		ISO 8501-3 – Grade P3	
COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[1]
Primer	Inorganic copolymer, inert multi polymeric matrix coating		150
Topcoat	Inorganic copolymer, inert multi polymeric matrix coating		150
Total min DFT			300
PERFORMANCE TEST[2]			
Table 2		1; 8	
INSPECTION AND TESTING			
Tests during work execution		Table 21	
Final visual		100% examination of coating	
Adhesion Crosscut		≥3A	
Final DFT		See item 14.3.2	
Repair system		Original coating systems	
NOTES: \1\ Maximum DFT shall be as per Paint Manufacturer.			

CS 9 - Coating System N°9

Coating System N°9			
Intended uses	Escape route, Supply Boat Handling Area, Walkways[6]		
Environment corrosivity	CX	Substrate Materials	Carbon steel
Minimum/maximum operating temperature		-50°C to 80°C	
SURFACE PREPARATION			
Standard/Grade		Sa 2 ½ / WAB-2	
Roughness		80 to 120 µm	
Water Soluble Salts		5 µg/cm²	
Steel preparation		ISO 8501-3 – Grade P3	
COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[1]
Primer	Epoxy or Epoxy Glass Flake		500
Topcoat[2]	Epoxy nonskid aggregate		2500
Total min DFT			3000
PERFORMANCE TEST[4]			
Table 2– primer		1; 2	
Table 2– coating system		1, 6, 7	
INSPECTION AND TESTING			
Tests during work execution		Table 21	
Final visual		100% examination of coating	
Adhesion		12MPa (except failure type A/B) (after 1° coat)	
Final DFT		See item 14.3.2	
Repair system		Original coating systems	

NOTES:

\1\ Maximum DFT shall be as per Paint Manufacturer.

\2\ Aggregate shall be non-sparking, pre-mixed in the liquid coat or evenly distributed over the surface. Particle size shall be between 1 mm to 5 mm.

\3\ The area on deck required for operation and maintenance of offloading shall be considered also as a walkway.

CS 10 - Coating System N°10

Coating System N°10			
Intended uses	Produced Water, Slop, Off-spec, Settling, Sludge, Bilge Water Settling, Equalization, Drain and Sewage Tanks Caisson (internal), Battery room.		
Environment corrosivity	Immersion	Substrate Materials	Carbon steel and Stainless steels
Minimum/maximum operating temperature		-20°C to 80°C	
SURFACE PREPARATION			
Standard/Grade		Sa 2 ½ / WAB-2	
Roughness		50 to 100 µm - carbon steel	30 to 85 µm - stainless steel
Water Soluble Salts		3 µg/cm²	
Steel preparation		ISO 8501-3 – Grade P3	
COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[1]
Primer	Epoxy Novolac[2]		250
Topcoat	Epoxy Novolac[2]		250
Total min DFT			500
PERFORMANCE TEST[3]			
Table 2		1;5;13;14;15;16, 20	
INSPECTION AND TESTING			
Tests during work execution		Table 21	
Final visual		100% examination of coating	
Adhesion		12MPa (except failure type A/B)	
Final DFT		See item 14.3.2	
Holiday detection		100%	
Repair system		Original coating systems	

NOTES:
\1\ Maximum DFT shall be as per Paint Manufacturer.
\2\ May be applied in one or two coats.

CS 11 - Coating System N°11

Coating System N°11			
Intended uses	Fresh Water Tanks, Distilled Water Tanks, Potable or Drinking Water Tanks, Hydrophore vessel		
Environment corrosivity	Potable water	Substrate Materials	Carbon steel and stainless steel
Minimum/maximum operating temperature		-20°C to 40°C	
SURFACE PREPARATION			
Standard/Grade		Sa 2 ½ / WAB-2	
Roughness		50 to 100 µm - carbon steel	30 to 85 µm - stainless steel
Water Soluble Salts		3 µg/cm²	
Steel preparation		ISO 8501-3 – Grade P3	
COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[1]
Primer	Epoxy[2, 3]		225
Topcoat	Epoxy [2, 3]		225
Total min DFT			450
PERFORMANCE TEST			
Table 2		1; 18, 20	
Track Record		Required	
INSPECTION AND TESTING			
Tests during work execution		Table 21	
Final visual		100% examination of coating	
Adhesion		12MPa (except failure type A/B)	
Final DFT		See item 14.3.2	
Holiday detection		100%	
Repair system		Original coating systems	

NOTES:

\1\ Maximum DFT shall be as per Paint Manufacturer.

\2\ May be applied in one or two coats.

\3\ Potable or Drinking Water Tanks shall receive a coating system that is in accordance with NSF/ANSI 61.

CS 12 - Coating System N°12

Coating System N°12			
Intended uses	Cargo Oil, Diesel, Fuel oil, Hydraulic oil Tanks and Equipment		
Environment corrosivity	Immersion	Substrate Materials	Carbon steel and Stainless Steel
Minimum/maximum operating temperature		-20°C to 60°C	
SURFACE PREPARATION			
Standard/Grade		Sa 2 ½ / WAB-2	
Roughness		50 to 100 µm - carbon steel	30 to 85 µm - stainless steel
Water Soluble Salts		3 µg/cm²	
Steel preparation		ISO 8501-3 – Grade P3	
COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[1]
Primer	Epoxy		225
Topcoat	Epoxy		225
Total min DFT			450
PERFORMANCE TEST			
Table 2		1; 9; 10;12, 20	
Track Record		Required	
INSPECTION AND TESTING			
Tests during work execution		Table 21	
Final visual		100% examination of coating	
Adhesion		12MPa (except failure type A/B)	
Final DFT		See item 14.3.2	
Holiday detection		100%	
Repair system		Original coating systems	

NOTES:
\1\ Maximum DFT shall be as per Paint Manufacturer. May be applied in one or two coats.

CS 13 - Coating System N°13

Coating System N°13			
Intended uses	Color requirements		
Environment corrosivity	N/A	Substrate Materials	CuNi; Aluminum, FRP, CPVC
Minimum/maximum operating temperature	-20°C to 80°C		
SURFACE PREPARATION			
Standard/Grade	See item 12.1		
Roughness	20 - 30µm for CuNi		
Water Soluble Salts	5 µg/cm²		
Steel preparation	ISO 8501-3 – Grade P3		
COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[1]
Primer	Epoxy Adherence Paint		25
Topcoat	Polyurethane		75
Total min DFT			100
PERFORMANCE TEST			
Not applicable			
INSPECTION AND TESTING			
Tests during work execution	Table 21		
Final visual	100% examination of coating		
Adhesion	7 MPa (except failure type A/B)		
Final DFT	See item 14.3.2		
Repair system	Original coating systems		
NOTES: \1\ Maximum DFT shall be as per Paint Manufacturer.			

CS 14 - Coating System N°14

Coating System N°14			
Intended uses	Internal coating of pressure vessel and other equipment		
Environment corrosivity	Process water, Utility water, Hydrocarbon liquids, gases and produced water.	Substrate Materials	Carbon steel or stainless steel
Minimum/maximum operating temperature		-20°C to 175°C	
Maximum design pressure		40 bar	
SURFACE PREPARATION			
Standard/Grade		Sa 2 ½	
Roughness		50 to 100 µm - carbon steel	30 to 85 µm - stainless steel
Water Soluble Salts		3 µg/cm²	
Steel preparation		ISO 8501-3 – Grade P3	
COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[1]
Coat	Epoxy novolac solventless enhanced with glass flakes or ceramic pigments		800
Total min DFT			800
PERFORMANCE TEST[3]			
Table 2		1;14;15;16; 17	
Track Record		Required	
INSPECTION AND TESTING			
Tests during work execution		Table 21	
Final visual		100% examination of coating	
Adhesion		15MPa (except failure type A/B)	
Final DFT		See item 14.3.2	
Holiday detection		100%	
Dimensional inspection		Flanges connected to process piping	
Repair system		Original coating systems	

NOTES:

\1\ Maximum DFT shall be as per Paint Manufacturer. May be applied in one or two coats.

\2\ PAINT MANUCTURER shall present documented testing or field experience relevant to the specific intended use of temperatures up to 175°C continuous.

CS 15 - Coating System N°15

Coating System N°15			
Intended uses	Cargo Oil, Diesel, Fuel oil, Hydraulic oil Tanks with T>60°C		
Environment corrosivity	Immersion	Substrate Materials	Carbon steel or stainless steel
Minimum/maximum operating temperature	-20°C to 80°C		
SURFACE PREPARATION			
Standard/Grade	Sa 2 ½ / WAB-2		
Roughness	50 to 100 µm - carbon steel	30 to 85 µm - stainless steel	
Water Soluble Salts	3 µg/cm²		
Steel preparation	ISO 8501-3 – Grade P3		
COATING SYSTEM			
Coat	Type of coat / binder	min DFT, µm[1]	
Primer	Epoxy, Epoxy Novolac, Phenolic Epoxy.	200	
Topcoat	Epoxy, Epoxy Novolac, Phenolic Epoxy.	200	
Total min DFT	400		
PERFORMANCE TEST[3]			
Table 2	1; 9; 10;12, 19, 20		
Track Record	Required as alternative to 19.		
INSPECTION AND TESTING			
Tests during work execution	Table 21		
Final visual	100% examination of coating		
Adhesion	15MPa (except failure type A/B)		
Final DFT	See item 14.3.2		
Holiday detection	100%		
Repair system	Original coating systems		

NOTES:
\1\ Maximum DFT shall be as per Paint Manufacturer. May be applied in one, two or three coats.

CS 16 - Coating System N°16

Coating System N°16			
Intended uses	Splash zone (including external caisson) Pull in sheave trolley and overhead crane		
Environment corrosivity	CX +Im4	Substrate Materials	Carbon steel and stainless steel
Minimum/maximum operating temperature		-50°C to 50°C	
SURFACE PREPARATION			
Standard/Grade		Sa 2 ½ / WAB-2	
Roughness		80 to 120 µm	
Water Soluble Salts		3 µg/cm²	
Steel preparation		ISO 8501-3 – Grade P3	
COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[1]
Primer	Epoxy, Glass flake or fiber reinforced epoxy		1000
Topcoat	Epoxy, Glass flake or fiber reinforced epoxy		
Total min DFT			1000
PERFORMANCE TEST[3]			
Table 2		1; 2 3;4;5;6.	
Track Record		Required	
INSPECTION AND TESTING			
Tests during work execution		Table 21	
Final visual		100% examination of coating	
Adhesion		12MPa (except failure type A/B)	
Final DFT		See item 14.3.2	
Holiday detection		100%	
Repair system		Original coating systems	

NOTES:
\1\ Maximum DFT shall be as per Paint Manufacturer. May be applied in one or two coats.

CS 17 - Coating System N°17

Coating System N°17			
Intended uses	Internal coating of piping		
Environment corrosivity	Process water, utility water, sea water, Hydrocarbon liquids, gases and produced water.	Substrate Materials	Carbon steel
Minimum/maximum operating temperature		-20°C to 70°C	
Minimum/maximum design pressure		100 bar	
SURFACE PREPARATION			
Standard/Grade		Sa 2 ½	
Roughness		50 to 100 µm	
Water Soluble Salts		2 µg/cm²	
Steel preparation		ISO 8501-3 – Grade P3	
COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[1]
Primer	FBE		400
Total min DFT			400
PERFORMANCE TEST			
18.5.3. , and Table 18			
INSPECTION AND TESTING			
Tests during work execution		Table 21	
Final visual		100% examination of coating	
Adhesion		12MPa (except failure type A/B)	
Final DFT		See item 14.3.2	
Delta Tg		Required	
Holiday detection		100%	
Dimensional inspection		Flanges	
Repair system		As defined by PAINT MANUFACTURER	
NOTES: \1\ See item 7.4.20.			

CS 18 - Coating System N°18

Coating System N°18			
Intended uses	Internal coating of piping		
Environment corrosivity	Process water, utility water, sea water, Hydrocarbon liquids, gases and produced water	Substrate Materials	Carbon steel
Minimum/maximum operating temperature		-20°C to 120°C	
Minimum/maximum design pressure		100 bar	
SURFACE PREPARATION			
Standard/Grade		Sa 2 ½	
Roughness		50 to 100 µm	
Water Soluble Salts		2 µg/cm²	
Steel preparation		ISO 8501-3 – Grade P3	
COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[1]
Primer	FBE NOVOLAC		400
Total min DFT			400
PERFORMANCE TEST[2]			
18.5.4. , and Table 18			
INSPECTION AND TESTING			
Tests during work execution		Table 21	
Final visual		100% examination of coating	
Adhesion		12MPa (except failure type A/B)	
Final DFT		See item 14.3.2	
Holiday detection		100%	
Dimensional inspection		Flanges	
Repair system		As defined by PAINT MANUFACTURER	

NOTES:
\1\ See item 7.4.20.

CS 19 - Coating System N°19

Coating System N°19			
Intended uses	Carbon Steel electric equipment and instruments located at controlled environmental rooms. Electric equipment and instruments stainless steel and aluminum		
Environment corrosivity	HVAC/ AC[1]	Substrate Materials	Carbon steel, stainless steel and aluminum
Minimum/maximum operating temperature		-20°C to 80°C	
SURFACE PREPARATION[2]			
Standard/Grade		Sa 2 ½	
Roughness		50 to 100 µm - carbon steel	30 to 85 µm - stainless steel
Water Soluble Salts		5 µg/cm² - carbon steel	3 µg/cm² - stainless steel
Steel preparation		ISO 8501-3 – Grade P3	
LIQUID COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[3]
Primer	Epoxy		100
Topcoat	Polyurethane		50
Total min DFT			150
ELETROSTATIC COATING			
Coat	Type of coat / binder		min DFT, µm[3]
Primer	Epoxy Powder Paint		90
Topcoat	Polyester		80
Total min DFT			170
PERFORMANCE TEST			
Table 4		Item 0	
INSPECTION AND TESTING			
Tests during work execution		Table 21[4]	
Final visual		100% examination of coating	
Adhesion		5MPa (except failure type A/B)	
Final DFT		See item 14.3.2	
Repair system		Original coating systems	

NOTES:
\1\ For stainless steel and aluminum substrate, this coating system is also applicable for CX.
\2\ For electrostatic coating see item 5.4.5, 5.4.6 and 5.4.7.
\3\ Maximum DFT shall be as per Paint Manufacturer.
\4\ As applicable.

CS 20 - Coating System N°20

Coating System N° 20			
Intended uses	Carbon steel instrument located outdoor		
Environment corrosivity	CX	Substrate Materials	Carbon steel
Minimum/maximum operating temperature		-20°C to 80°C	
SURFACE PREPARATION			
Standard/Grade		Sa 2 ½ / WAB-2	
Roughness		50 to 100µm	
Water Soluble Salts		5 µg/cm²	
Steel preparation		ISO 8501-3 – Grade P3	
LIQUID COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[1]
Primer	Zinc rich epoxy		75
2º coat	Epoxy		100
Topcoat	Polyurethane		50
Total min DFT			225
ELETROSTATIC COATING			
Coat	Type of coat / binder		min DFT, µm[1]
Primer	Epoxy Powder Paint Pigmented with Metallic Zinc		90
Topcoat	Polyester		80
Total min DFT			170
PERFORMANCE TEST[3]			
Table 4		Item 0	
Table 2		1; 2;	
INSPECTION AND TESTING			
Tests during work execution		Table 21[2]	
Final visual		100% examination of coating	
Adhesion		5MPa (except failure type A/B)	
Final DFT		See item 14.3.2	
Holiday detection		NO	
Dimensional inspection		NO	
Repair system		Original coating systems	

NOTES:
\1\ For electrostatic coating see item 5.4.5, 5.4.6 and 5.4.7.
\2\ Maximum DFT shall be as per Paint Manufacturer.
\3\ As applicable.

CS 21 - Coating System N°21

Coating System N° 21			
Intended uses	Internal coating of valves, or for piping / equipment with high corrosive fluids where the project specifies		
Environment corrosivity	High corrosive fluids	Substrate Materials	Carbon steel and Stainless Steel
Minimum/maximum operating temperature		-20°C to 180°C	
Minimum/maximum design pressure		100 bar	
SURFACE PREPARATION			
Standard/Grade		Sa 2 ½	
Roughness		50 to 100 µm - carbon steel	30 to 85 µm - stainless steel
Water Soluble Salts		2 µg/cm²	
Steel preparation		ISO 8501-3 – Grade P3	
COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[1]
Primer	FLUPOLYMERIC COATING		600
Total min DFT			600
PERFORMANCE TEST			
Table 7		Table 18	
INSPECTION AND TESTING			
Tests during work execution		Table 21	
Final visual		100% examination of coating	
Final DFT		See item 14.3.2	
Holiday detection		100%	
Dimensional inspection		Flanges	
Repair system		Original system	

NOTES:
\1\ See item 7.4.20.

CS 22 - Coating System N°22

Coating System N° 22			
Intended uses	Upper Riser Balcony and Pull in Structure		
Environment corrosivity	CX+Im4	Substrate Materials	Carbon steel
Minimum/maximum operating temperature		-50°C to 80°C	
SURFACE PREPARATION			
Standard/Grade		Sa 2 ½	
Roughness		80 to 120 µm	
Water Soluble Salts		3 µg/cm²	
Steel preparation		ISO 8501-3 – Grade P3	
COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[1]
Primer	Zinc Rich Epoxy Primer		60
2º coat	Epoxy, Glass flake or fiber reinforced epoxy r		1000
Topcoat	Epoxy, Glass flake or fiber reinforced epoxy		
Total min DFT			1060
PERFORMANCE TEST[4]			
Table 2		1; 2 3; 4;5; 6.	
INSPECTION AND TESTING			
Tests during work execution		Table 21	
Final visual		100% examination of coating	
Adhesion		5MPa (except failure A/B)	
Final DFT		See item 14.3.2	
Holiday detection		NO	
Repair system		CS 16 - Coating System N°16	

NOTES:
\1\ Maximum DFT shall be as per Paint Manufacturer. May be applied in two or three coats.

CS 23 - Coating System N°23

Coating System N°23			
Intended uses	Process Plant Deck Primary Escape Route, Helideck Landing Area		
Environment corrosivity	CX	Substrate Materials	Carbon steel and Aluminum
Minimum/maximum operating temperature		-15°C to 60°C	
SURFACE PREPARATION			
Standard/Grade		Sa 2 ½ / WAB-2	
Roughness		80 to 120 µm	
Water Soluble Salts		5 µg/cm²	
Steel preparation		ISO 8501-3 – Grade P3	
COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[1]
Primer	Epoxy / Compatibility Primer		3000
2° coat	PUR/ PUA		
Topcoat[2, 3]	Finishing Coat Anti-skid		70
Total min DFT			3070
PERFORMANCE TEST[4]			
Table 3			
INSPECTION AND TESTING			
Tests during work execution		Table 21	
Final visual		100% examination of coating	
Adhesion		10MPa (except failure type A/B)	
Final DFT		See item 14.3.2	
Hardness Shore		120-80% performance qualification value	
Repair system		DEFINED BY PAINT MANUFACTURER	

NOTES:

\1\ Maximum DFT shall be as per Paint Manufacturer.

\2\ Aggregate shall be non-sparking, pre-mixed in the liquid coat or evenly distributed over the surface. Particle size shall be between 1 mm to 5 mm.

\3\ Aggregate shall be preferably sprayed directly to the elastomeric coating before its curing is complete or shall be added to finishing coat. Anti-skid effect may be provided by over spray procedure. In the case of topcoat, the antiskid aggregate shall be added directly to the finishing coat.

\4\ The coating applicator shall be a company that has equipment, labor and a quality system with the minimum requirements established by the by coating manufacturer.

CS 24 - Coating System N°24

Coating System N°24			
Intended uses	Lay down area AFT (M-16), Pipe Rack Process Plant Deck Main Walkway, Forecastle deck floor; Poop deck Floor. Warehouse and Mechanical Workshop Floor.		
Environment corrosivity	CX	Substrate Materials	Carbon steel
Minimum/maximum operating temperature	-15°C to 60°C		
SURFACE PREPARATION			
Standard/Grade	Sa 2 ½ / WAB-2		
Roughness	80 to 120 µm		
Water Soluble Salts	5 µg/cm²		
Steel preparation	ISO 8501-3 – Grade P3		
COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[1]
Primer	Epoxy / Compatibility Primer		3000
2° coat	PUR/ PUA		
Topcoat	Finishing coat		70
Total min DFT			3070
PERFORMANCE TEST[2]			
Table 3			
INSPECTION AND TESTING			
Tests during work execution	Table 21		
Final visual	100% examination of coating		
Adhesion	10MPa (except failure type A/B)		
Final DFT	See item 14.3.2		
Hardness Shore	120-80% performance qualification value		
Repair system	DEFINED BY PAINT MANUFACTURER		

NOTES:
\1\ Maximum DFT shall be as per Paint Manufacturer.
\2\ The coating applicator shall be a company that has equipment, labor and a quality system with the minimum requirements established by the by coating manufacturer.

CS 25 - Coating System N°25

Coating System N°25			
Intended uses	Water Ballast Tanks, Air Vessels		
Environment corrosivity	Immersion	Substrate Materials	Carbon steel and stainless steel
Minimum/maximum operating temperature		-20°C to 60°C	
SURFACE PREPARATION			
Standard/Grade		Sa 2 ½ / WAB-2	
Roughness		50 to 100 µm - carbon steel	30 to 85 µm - stainless steel
Water Soluble Salts		3 µg/cm²	
Steel preparation		ISO 8501-3 – Grade P3	
COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[1]
Primer	Epoxy		225
Topcoat	Epoxy		225
Total min DFT			450
PERFORMANCE TEST			
Table 2		1; 9; 10;11, 20	
Track Record		Required	
INSPECTION AND TESTING			
Tests during work execution		Table 21	
Final visual		100% examination of coating	
Adhesion		12MPa (except failure type A/B)	
Final DFT		See item 14.3.2	
Holiday detection		100%	
Repair system		Original coating systems	

NOTES:
\1\ Maximum DFT shall be as per Paint Manufacturer. May be applied in one or two coats.

CS 26 - Coating System N°26

Coating System N° 26			
Intended uses	Water Ballast Tanks with T >60°C		
Environment corrosivity	Imersion	Substrate Materials	Carbon steel and stainless steel
Minimum/maximum operating temperature		-20°C to 80°C	
SURFACE PREPARATION			
Standard/Grade		Sa 2 ½ / WAB-2	
Roughness		50 to 100 µm - carbon steel	30 to 85 µm - stainless steel
Water Soluble Salts		3 µg/cm²	
Steel preparation		ISO 8501-3 – Grade P3	
COATING SYSTEM			
Coat	Type of coat / binder		min DFT, µm[1]
Primer	Epoxy, Epoxy novolac, phenolic epoxy		200
Topcoat	Epoxy, Epoxy novolac, phenolic epoxy		200
Total min DFT			400
PERFORMANCE TEST[2]			
Table 2		1; 9; 10;11, 19, 20	
Track Record		Required as alternative to 19.	
INSPECTION AND TESTING			
Tests during work execution		Table 21	
Final visual		100% examination of coating	
Adhesion		12MPa (except failure type A/B)	
Final DFT		See item 14.3.2	
Holiday detection		100%	
Repair system		Original coating systems	

NOTES:
\1\ Maximum DFT shall be as per Paint Manufacturer. May be applied in one or two coats.

ANNEX B – QUICK TEST FOR PRESENCE OF OIL OR GREASE SURFACE CONTAMINATION

B.1 Introduction:

B.1.1 This test aims to quickly detection of oil or grease contamination on surfaces prior to the painting works.

B.2 Test solution

B.2.1 Deionized or distilled water used in accordance with ASTM F22.

B.3 Test conditions

B.3.1 Spray over the surface a thin film of deionized or distilled water. The area shall be representative of the total area to be painted.

B.3.2 Proceed a visual inspection of the sprayed surface. If the sprayed surface is covered with a thin film of water, there is no oil or grease contamination. Otherwise, if water drops are formed over the surface, the oil and grease contamination shall be assumed.

ANNEX C – ALTERNATIVE THICKNESS MEASUREMENT PROCEDURE

C.1 Introduction:

C.1.1 This test is based on ISO 19840 but a statistical approach, to evaluate a discreet number which can quickly refereed to a unit area inspected, has been added.

C.1.2 Been based on ISO 19840 same parts of standard are modified or new are added.

C.2 Modified items of ISO 19840

C.2.1 Additions:

C.3 Terms and Definitions:

Appraisal Dry Film Thickness (ADFT): statistically discrete value corresponding to the Dry Film Thickness of the whole area.

C.4 Modifications:

C.4.1. – Item 6.1 Sampling plan:

The sampling plan defines the number of measurements to be taken in an inspection area. Two kinds of structures shall be considered for the purpose of sampling:

a) Uniform structures (or areas with minor protuberances or reentrances) typically pressure vessels or pipelines.

b) Complex structures with many protuberances or reentrances, typically ballast or cargo tanks of FPSO´s: all type of area (e.g., stiffeners) shall be represented by number of measurements that corresponds to their contribution to entire area (e.g., if the stiffeners correspond to 10% of the total area, 10% of the measurements shall be taken from stiffeners).

The minimum number of randomly taken measurements required for calculation the ADFT on painted area is given in TABLE C.1.

TABLE C.1 - SAMPLING PLAN.

Measurement unit		Minimum number of measurements
Pipelines (length: m)	Equipment or pieces (area: m²)	
Up to 30		30
Above 30 to 100		1 measurement each 1 m² or 30 measurements, whichever is greater
Above 100(see note)		Add 10 for every additional 100 m² (equipment) or 100 m (pipelines)
Note: It is recommended to divide huge structures into smaller inspection areas, not exceeding 5000 m².		

C.4.2. – Item 6.2 Measurement:

All data collection shall be preceded by adjustment and verification of the instrument carried out in accordance with 6.1. The instrument shall be used in accordance with manufacturer's instructions.

Following completion of a series of measurements, and preferably during the measurements, the adjustment of the instrument shall be re-verified. If this is not in accordance with 6.1, the results of the measurements shall be rejected.

When during a series of measurements an individual dry film thickness value is lower than the minimum total thickness [see 8b)], four new equally separated measurements around an imaginary circle,

centered in the previous measurement, with a radius of no more than 30 mm, shall be taken. Repeat this procedure in case of any measurement is lower than the minimum total thickness, until acceptable values be measured. All measurements shall be part of data set.

C.4.3. – Item 6.3 Statistical analysis:

All individual dry film thickness values shall be assumed to belong to a one normal population and the standard deviation and mean value shall be calculated according to this paradigm.

Calculate ADFT value according to following equation:

ADFT90 = $\bar{x}$ – 1.28 σ.

When:

ADFT – Appraisal Dry Film Thickness,

$\bar{x}$ – Average of DFT measurements,

σ – Standard deviation of DFT measurements.

C.4.4. – Item 8 Expression of results:

The results of the ADFT measurement shall be recorded (see Clause 10) and indicated as representative number of the painted area, expressed in µm or mm as appropriate. Also is required to report the statistical values of Standard deviation (σ) and mean value ($\bar{x}$) of each sampling area.

C.4.5. – Item 9 Acceptance/rejection criteria:

For the acceptance of an inspection area the following criteria shall be fulfilled:

a) The ADFT value shall higher than nominal dry film thickness (which is considered the average between the minimum total thickness and maximum total thickness mentioned in ANNEX A).

b) No individual thickness measurement shall be lower than the minimum total thickness mentioned in ANNEX A. In case of any individual thickness measurement value lower than minimum total thickness, the painted area shall be inspected with Holiday detection technique according to NACE RP 0188 and shall be reject in case of any holiday detected.

If the acceptance criteria above are not met, the inspected area shall be rejected.

C.4.6. – Item 10 Test report:

The test report shall contain at least the following information:

a) a reference to this Technical Specification.

b) all details necessary to identify the painted area inspected.

c) all details necessary to identify the paint or paint system tested.

d) all details necessary to identify the substrate.

e) all details necessary to identify the surface preparation of the substrate.

f) the measurement instrument used (including serial number).

g) the method used for adjusting the instrument.

h) the correction value used.

i) the number of thickness measurements taken in each painted area.

j) the results of the measurement (ADFT, $\bar{x}$, σ), as indicated in Clause 8.

k) the identification of inspection areas, and whether or not the acceptance criteria for each inspection area were met.

l) the ambient temperature during the measurements (see Note 1).

m) the surface temperature during the measurements.

NOTE 1: Approximate temperature is important information for verifying the circumstances during the measurement. Extreme temperatures can affect instrument performance. See the technical information provided by the instrument manufacturer.

o) When required by BUYER, all individual thickness measurements.

p) the date of the measurements.

q) the name(s) of the inspector(s) who conducted the measurements and made the calculations.