



COATINGS SPECIFICATION

FOR THE

CARTAGENA REFINERY EXPANSION PROJECT

CB&I CONTRACT NO. 166000

Prepared By: Mechanical Engineering, Houston

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	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
 Refinería de Cartagena S.A.		Revision: 7
		Date: 31-Mar-11
		Page: 2 of 28

TABLE OF CONTENTS

1	SCOPE.....	4
	1.1 General.....	4
	1.2 Definitions.....	4
	1.3 Exclusions.....	5
2	SELLER RESPONSIBILITY.....	6
3	REGULATIONS	6
4	REFERENCES.....	6
	4.1 Codes	6
	4.2 Standards	7
5	DESIGN	7
	5.1 General.....	7
6	SUBMITTALS	9
	6.1 Documents to be Submitted by Seller	9
7	MATERIALS	9
	7.1 Material Manufacturers	9
	7.2 Inorganic Zinc Primer.....	9
	7.3 Organic Zinc Primer.....	9
	7.4 Type II Zinc Powder	9
	7.5 Machined-Surface Coatings.....	10
	7.6 Abrasive Materials	10
	7.7 Thinners, Solvents, and Cleaners	10
	7.8 Touch-Up Materials.....	10
8	SHIPPING, HANDLING, AND STORAGE	10
	8.1 Delivery and Storage	10
	8.2 Date of Materials.....	10
9	EQUIPMENT	11
	9.1 General Requirements.....	11
10	SURFACE PREPARATIONS.....	11
	10.1 General Requirements.....	11
	10.2 Steel Which Has Been Shop Primed Only	12
	10.3 Galvanized Steel.....	12
	10.4 Damaged hot-dipped galvanized steel	12
11	MIXING AND APPLYING COATINGS	13
	11.1 General Requirements.....	13
12	INSPECTION AND TESTING	15
	12.1 General Requirements.....	15
	12.2 Surface Preparation Inspection	15
	12.3 Coating Inspection	16
13	REMEDIAL WORK	16

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	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
 Refineria de Cartagena S.A.		Revision: 7
		Date: 31-Mar-11
		Page: 3 of 28

	13.1 Touch-Up.....	16
14	ADDITIONAL REQUIREMENTS.....	17
15	APPENDICES	18
	15.1 Appendix A - Paint Products	18
	15.2 Appendix B - Painting Summary for Equipment, Piping, & Structures	19
	15.3 Appendix C - Final Coat Colors for Piping.....	27
	15.4 Appendix D - Paint Codes Requirement for Attachments, Flanges and Valves ..	28

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	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
 Refinería de Cartagena S.A.		Revision: 7
		Date: 31-Mar-11
		Page: 4 of 28

1 SCOPE

1.1 General

- 1.1.1 This standard specification establishes and defines surface preparation and protective coating systems to be applied to vessels, exchangers, heaters, machinery, instruments, piping, structures, masonry above grade, and other items.
- 1.1.2 Shop fabricated equipment and packaged unit with associated piping are to have surface preparation, primer, intermediate (where specified) and finish coat applied in the shop by the Seller prior to shipment.
- 1.1.3 Shop fabricated pipe spools and bulk piping are to have surface preparation, primer, intermediate (where specified) and finish coat applied in the shop or in the field as agreed in the purchase document.
- 1.1.4 The paint products referenced by trade names within this specification are listed in the Appendix A to set a standard of quality. Equivalent paint products of other manufacturers will be acceptable if approved in writing by Purchaser's Engineering Department.

1.2 Definitions

- Protective Coating and Paint – used synonymously throughout this specification.
- Minimum Dry Film Thickness (MDFT) specified in (mils) and SI microns. One mil equals 25 microns.
- Dry Film Thickness (DFT) specified in mils or microns.
- Carbon Steel – steel containing up to two (2) percent carbon.
- Low Alloy Steel – steel containing up to five and one-half (5-1/2) percent chromium or three and one-half (3-1/2) percent nickel.
- Maximum Operating Temperature of a Line or Vessel – the temperature for determining the coating system.
- Holiday – unpainted spot, thin spot or void in the coating film which eventually could allow moisture or other contaminants to contact substrate.
- Seller – Party responsible for the surface preparation and application of external coating.
- Purchaser – Owner or Owner's authorized agent.

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	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
 Refineria de Cartagena S.A.		Revision: 7
		Date: 31-Mar-11
		Page: 5 of 28

1.3 Exclusions

- 1.3.1 This specification excludes underground piping required to be coated and wrapped.
- 1.3.2 This specification excludes internal lining of storage tanks and architectural paint requirements.
- 1.3.3 The following surfaces shall not be painted unless specified in other applicable purchase documents.
- Internal surfaces of piping and equipment
 - Corten steel
 - Brick work and tile, concrete fireproofing, concrete
 - Plastic, glass, rubber, mastic
 - Aluminum, brass, galvanized steel (except for safety color) or zinc anodes
 - Un-insulated stainless steel and insulated stainless steel <-40°F and >300 (<-40°C and >150°C) except for shipping protection
 - Machined parts of operating equipment and gasket surfaces
 - Factory finished items (including nameplates) except to match color scheme
 - Metal jacket over insulation
 - Anode attachment points that must provide a conductive path between anode and cathodically protected steel
 - Valve stems, motor shafts and other such moving parts in order not to impair their free movement
 - Coat and Wrap coated underground pipe
- 1.3.4 The items listed above shall be painted for corrosion protection when specified in other applicable purchase document(s).
- 1.3.5 Paint and coating materials containing lead shall not be used on any piping, equipment or packaged units.

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	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
 Refineria de Cartagena S.A.		Revision: 7
		Date: 31-Mar-11
		Page: 6 of 28

2 SELLER RESPONSIBILITY

- 2.1** Any conflict between the requirements of this specification and related codes, standards, data sheets, drawings, requisition, etc., shall be referred to Purchaser 's engineering department for clarification/ resolution.
- 2.2** Seller shall not make assumptions to replace information not furnished by Purchaser. Seller is required to obtain necessary information from Purchaser or other reliable sources. Any and all claims arising from lack of knowledge of required information will be rejected by Purchaser.
- 2.3** Seller shall list and fully describe all deviations from this specification and the related codes.
- 2.4** Seller is responsible for furnishing all material, equipment, labor, application, inspecting and testing of coatings.
- 2.5** Seller shall take into account all weather conditions and logistics consequent to the job location for coating of field erected tanks.

3 REGULATIONS

This specification requires compliance with all applicable Federal, State and Local laws and regulations.

4 REFERENCES

The following codes and standards, including applicable addenda form part of this specification to the extent specified herein.

4.1 Codes

Comply with all applicable federal, state and local codes including:

ASTM	American Society for Testing and Materials
A 53	Specification for Pipe, Steel, Black and Hot Dipped, Zinc coated, welded and seamless
A123	Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Plates, Bars and Strip.
A153	Specification for Zinc-Coating (Hot-Dip) on Iron and Steel Hardware
D 520	Standard Specification for Zinc Dust Pigment
D 4285	Test Method for Indicating Oil or Water in Compressed Air
D 4417	Test Method for Field Measurement of Surface Profile of Blast Cleaned Steel
E 337	Test for Relative Humidity by Wet-and-Dry-Bulb Psychrometer

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	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
 Refineria de Cartagena S.A.		Revision: 7
		Date: 31-Mar-11
		Page: 7 of 28

4.2 Standards

Comply with the following standards:

SSPC	Steel Structures Painting Council
SSPC - AB1	Mineral and Slag Abrasive
SSPC - SP1	Solvent cleaning
SSPC - SP2	Hand Tool Cleaning
SSPC - SP3	Power Tool Cleaning
SSPC - SP5	White Metal Blast Cleaning
SSPC - SP6	Commercial Blast Cleaning
SSPC - SP7	Brush-off Blast Cleaning
SSPC - SP8	Pickling
SSPC - SP10	Near-White Metal Blast Cleaning
SSPC - SP11	Power Tool Cleaning to Bare Metal
SSPC - PA1	Shop, Field and Maintenance Painting of Steel
SSPC - PA2	Measurement of Dry Paint Thickness with Magnetic Gages
SSPC - PA3	A Guide to Safety and Painting Application
SSPC - Paint 20	Zinc Rich Primers

5 DESIGN

5.1 General

- 5.1.1 Paint systems for different items, either insulated or not insulated; different operating temperatures; and carbon steel or stainless steel are listed in Appendix B. This table defines the requirement of surface preparation, numbers of coats with minimum dry film thickness. Appendix A identifies different manufacturer's product for generic types of paints. Appendix C specified the finish color requirement.
- 5.1.2 All surfaces exposed to view in the assembled condition including uninsulated surfaces of insulated items (such as piping, equipment, etc.) shall be finish coated to paint system 1, 2, 3 or 4 as required by maximum operating temperature.
- 5.1.3 Fireproofed surfaces shall be treated same as insulated surfaces in regard to painting per this specification and shall be painted per paint system 5.
- 5.1.4 Lines and equipment receiving partial insulation or metal cages for personnel protection insulation shall be treated as uninsulated items for selection of paint and shall be painted per paint system 1, 2, 3 or 4 as required by maximum operating temperature.
- 5.1.5 Maximum operating temperature shall be used to select paint system for lines and equipment.

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	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
 Refineria de Cartagena S.A.		Revision: 7
		Date: 31-Mar-11
		Page: 8 of 28

- 5.1.6 For heat exchanger, higher operating temperature of inlet and outlet temperature shall be used to select paint system.
- 5.1.7 Items such as pumps, motors, compressors, switchgear, control panels, control valves and relief valves including actuators can be coated with manufacturer's standard coating system. The proposed paint system shall meet the temperature and environmental corrosively requirements. The Seller shall submit proposed paint procedure to Purchaser for review and approval before proceeding with the work.
- 5.1.8 Spec valves (bulk valves) shall be purchased with a manufacturer's standard coating system. The Seller shall submit proposed paint procedure to Purchaser for review. Purchaser shall coat spec valves same as associated line (pipe) paint system in the shop or field. If associated line (pipe) is insulated, valves shall be considered uninsulated and shall be painted per paint system 1, 2, 3 or 4.
- 5.1.9 Purchaser shall clean the surfaces before painting valves in the field or shop with appropriate paint system.
- 5.1.10 Paint System 1 shall be applied over manufacturer's standard paint for operating temperature 200°F and under. Surfaces shall be cleaned, touch up any damaged paint and apply intermediate and finish coat of paint System 1.
- 5.1.11 Paint System 2, 3 or 4 applied for operating temperature above 200°F. If valves are coated with Alkyd or Epoxy, paint shall be removed by either blasting the surfaces or wirebrush cleaning. Paint System 2, 3 or 4, as required, shall be applied over cleaned surfaces. If valves are coated with inorganic zinc primer, it shall be cleaned and touch up any damaged primer and apply intermediate and finish coat as required per Paint System 2 or 3. For paint system 4, two coats of high heat silicone shall be applied over inorganic zinc (same as paint system 3).
- 5.1.12 Equipment, which has the Manufacturer's standard coating, shall be top-coated in the field if it is necessary to match a color scheme, if the equipment is subject to attack from corrosive environment or to repaint damaged areas.
- 5.1.13 Machined surfaces such as threads, valve stems, gasket contact surfaces etc. shall be protected with a petroleum soluble rust inhibitor.
- 5.1.14 Bolt holes shall be final coated with same paint system as equipment or valves. As a minimum, a coat of primer is required in the bolt holes.
- 5.1.15 Stainless steel equipment which are transported over ocean and shipped as deck cargo shall be shop coated per paint system 7 whether insulated or not.

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	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
 Refinería de Cartagena S.A.		Revision: 7
		Date: 31-Mar-11
		Page: 9 of 28

5.1.16 Stainless steel piping and valves shall be protected against atmospheric corrosion in transit. If they are not protected during transit, they shall be shop coated with paint system 7.

5.1.17 Any paint or crayon used for color-coding austenitic materials shall be free of lead, zinc, sulphur and chlorides.

5.1.18 Flange Connection in HF service shall be coated with Acid Detection Paint for leak detection. Acid Detection Paint shall be ON GUARD or approved equal.

6 SUBMITTALS

6.1 Documents to be Submitted by Seller

6.1.1 Coating systems and/or products other than those listed in Appendixes A & B require written review and approval prior to use.

6.1.2 For the paint systems listed in this specification, the Seller shall provide written procedures for storage, handling, surface preparation, environmental control, application, touch-up and repair, curing, and inspection along with "Daily Inspection Report" form for review and approval prior to proceed with painting Work. Conflicts, if any, between the Coating Manufacturer's recommendations and this specification shall be noted in writing to Purchaser for resolution.

6.1.3 A disposal procedure for paint waste materials.

7 MATERIALS

7.1 Material Manufacturers

7.1.1 Unless otherwise specified, all coating material shall be as specified by the Purchaser in Appendix A, Paint Products.

7.1.2 All materials applied to any one surface or piece of equipment shall be products of a single manufacturer.

7.2 Inorganic Zinc Primer

Inorganic zinc primer shall meet the requirements of SSPC-Paint 20, Type I, Level 1 (minimum 85% zinc dust by weight in dry film).

7.3 Organic Zinc Primer

Organic zinc rich primer shall meet the requirements of SSPC-Paint 20, Type II, Level 1 (minimum 85% zinc dust by weight in dry film).

7.4 Type II Zinc Powder

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	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
 Refinería de Cartagena S.A.		Revision: 7
		Date: 31-Mar-11
		Page: 10 of 28

Type II zinc powder per ASTM D 520 shall be used in the formulation. Type II zinc powder limits the total lead content to 0.01% maximum.

7.5 Machined-Surface Coatings

Machined surfaces shall be protected with a temporary preservative, such as Denso Paste or approved equal.

7.6 Abrasive Materials

Abrasives for blast cleaning shall be clean and dry, furnished either in bulk or packaged, and shall be free of oil or contaminants. The particle size shall be capable of producing the specified surface profile. Mineral and slag abrasives shall meet the requirements of SSPC AB1. Silica sand shall not be used.

7.7 Thinners, Solvents, and Cleaners

Thinners, solvents, and cleaners shall be as manufactured or recommended by the coating material manufacturer and shall be identified by the product number or generic formulation.

7.8 Touch-Up Materials

Materials for touch-up of damaged areas of surfaces shall be the same as or equivalent to those that originally applied.

8 SHIPPING, HANDLING, AND STORAGE

8.1 Delivery and Storage

8.1.1 Coating materials shall be delivered to the place of application in the manufacturer's unopened, original containers bearing a legible product designation, batch number, expiration date, shelf life, data of manufacture and color code. Containers, which are damaged, shall not be used.

8.1.2 The material shall be handled and stored in accordance with the manufacturer's latest published instructions and shall be protected from damage, moisture, direct sunlight, and temperatures below 41°F (5°C) or above 90°F (32°C). Storage facility shall be well ventilated and free from open flame or other sources of ignition.

8.2 Date of Materials

8.2.1 The coating materials shall be used within the manufacturer's published shelf life.

8.2.2 Containers of coatings or components shall not be opened unless for immediate use.

8.2.3 Handling of Coated Items

Coated items shall be protected on nonabrasive supports during storage. Coated surfaces shall be protected from damage during lifting or handling.

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  Refinería de Cartagena S.A.	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
		Revision: 7
		Date: 31-Mar-11
		Page: 11 of 28

9 EQUIPMENT

9.1 General Requirements

- 9.1.1 Application equipment shall be as recommended by the coating's manufacturer and shall be suitable to apply the coating as specified.
- 9.1.2 Equipment air supply lines shall be equipped with traps to remove moisture and oil as close to the point as possible. Air supply shall be tested for oil and water contamination in accordance with ASTM D4285.

10 SURFACE PREPARATIONS

10.1 General Requirements

- 10.1.1 Prior to the start of work, the Seller shall examine all surfaces to be coated to determine their acceptability for the specified work. If the surfaces are found to be unacceptable, the Seller shall immediately notify Purchaser in writing and shall not commence work until corrective action has been taken. Commencement of work prior to the taking of corrective action shall preclude any subsequent claim by the Seller. Purchaser may require corrective action at the Seller's expense.
- 10.1.2 Cleaning and coating shall be coordinated with other fabrication operations. Prior to starting any cleaning or coating operations, the Seller shall assure that the surface is ready for cleaning and coating. Areas, which may become inaccessible or difficult to paint after erection, shall be painted prior to assembly or erection.
- 10.1.3 Where possible, surfaces to be coated shall be shot or grit blast cleaned. Where abrasive blasting is impractical SSPC SP-11, "Power Tool Clean to Bare Metal" may be substituted. Power tools used to clean carbon steel shall not be used to clean stainless steel.
- 10.1.4 The surface profile of the steel cleaned by blasting shall be as specified in Appendix B.
- 10.1.5 The abrasive mixture and the compressed air shall be clean, dry, and oil-free. Traps, in addition to oil and water extractors mounted on the compressor, shall be used in compressed air lines to remove oil and moisture from air close to the point of use.
- 10.1.6 Prior to blast cleaning, contamination shall be removed from the steel surfaces. Oil and grease shall be removed by solvent cleaning in accordance with SSPC SP-1.
- 10.1.7 Blast cleaning shall not be performed in the immediate area where coating or curing of coated surfaces is in progress. All surfaces and equipment, which are not to be coated, shall be suitably protected from blast cleaning.

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	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
 Refinería de Cartagena S.A.		Revision: 7
		Date: 31-Mar-11
		Page: 12 of 28

- 10.1.8 Burrs, slivers, scabs, and weld spatter, which become visible after blasting, shall be removed. Repaired areas shall have the surface profile suitably restored.
- 10.1.9 If visible rusting occurs or if the cleaned surface become wet or otherwise contaminated, these surfaces shall be re-cleaned to the degree specified. Cleaned surfaces remaining uncoated overnight shall be re-cleaned to remove rust.
- 10.1.10 After cleaning and immediately before coating, dust shall be removed with compressed air, free of oil and moisture. Vacuuming shall be used if the surface is not dust free, as determined by Purchaser's inspector.
- 10.1.11 Machined surfaces shall be solvent wiped in accordance with SSPC-SP 1 before the application of machined-surface coating and shall be protected from damage due to cleaning and coating operations.
- 10.1.12 Machined portion of pipe flange mating faces shall be masked with plywood or plastic to protect internal components. The remaining part of the flange face (including boltholes) shall then be cleaned and coated.
- 10.1.13 For equipment no coatings are to be applied to welds of items requiring hydrostatic testing prior to testing.
- 10.1.14 For piping weld joints may be primed and painted prior to hydrostatic testing.
- 10.1.15 Equipment shall have all openings plugged, masked and/or blinded before abrasive blasting.

10.2 Steel Which Has Been Shop Primed Only

After erection and/or installation but before topcoating, items previously primed shall be examined for damage and for unprimed areas. All oil and grease shall first be removed in accordance with SSPC SP-1. Following solvent cleaning all loose dirt, chalk, and other contaminants shall be removed by high-pressure water wash or other Purchaser approved techniques. Unprimed and damaged areas shall be power tool cleaned in accordance with SSPC SP-11, and recoated prior to application of finish coat(s).

10.3 Galvanized Steel

Where galvanized steel is to be coated (for safety color or under fireproofing) the surface shall be prepared with etch primer, washed off and allowed to dry. The cleaned surface shall top coated with epoxy of specified color (e.g. safety yellow for tripping hazard)

10.4 Damaged hot-dipped galvanized steel

Damaged hot-dipped galvanized steel shall be repaired as follows:

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	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
 Refineria de Cartagena S.A.		Revision: 7
		Date: 31-Mar-11
		Page: 13 of 28

10.4.1 For weld repair and minor damage; clean the damaged area per SSPC SP-3. Touch-up with a high zinc dust content cold galvanizing paint such as Galvacon, ZRC, Subox, Galvalox I, or equivalent.

10.4.2 For major galvanized repair, abrasive blast clean damaged area to SSPC SP-6, "Commercial Blast." Sand or screen intact galvanized surface to a featheredge. Spray one (1) coat of organic zinc to a minimum dry film thickness of 2.5 mils (67 micron).

11 MIXING AND APPLYING COATINGS

11.1 General Requirements

11.1.1 Mixing, thinning, applying, and curing of the coating material shall be in accordance with the manufacturer's latest published instruction, SSPC PA-1, and the requirements specified herein. When multiple component units are mixed, each component shall be mixed separately prior to the mixing of the combined materials. Only complete kits shall be mixed, no partial kits will be allowed at any time. Improper thinning can result in increased emissions of volatile organic compounds (VOC).

11.1.2 Coating materials shall be thoroughly mixed until they are smooth and free from lumps, and then strained through a 30 mesh or finer screen. Material shall be agitated to keep the solids in suspension if necessary. Inorganic zinc coatings must be mechanically agitated at all times. The pot life of any paint shall be carefully noted, and any mixed paint that has exceeded pot life shall be discarded irrespective of apparent condition.

11.1.3 The cleaned surface shall be coated before any visible rust forms on the surface. No coating material shall be applied closer than 7 inch (175 mm) from adjacent noncleaned surfaces.

11.1.4 The application of the coating shall be performed only when the environmental conditions meet the parameters specified in this Specification. Relative humidity shall be 80 percent or below. If humidity falls below 50 percent, the cure of inorganic zinc primer will be inhibited. The cure time shall be extended or the manufacturer's written procedure for cure shall be followed.

11.1.5 Enclosures to permit coating of surfaces during inclement weather may be used, provided the environmental restrictions specified are maintained throughout the coating and curing periods.

11.1.6 The Seller shall not apply coatings unless the temperature of the substrate is always a minimum of 5°F (3°C) above the dew point. The substrate temperature during coating application and curing shall be maintained between a minimum of 50°F (10°C) and a

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	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
 Refinería de Cartagena S.A.		Revision: 7
		Date: 31-Mar-11
		Page: 14 of 28

maximum of 109°F (43°C).

- 11.1.7 For application and curing of epoxy below 50°F (10°C) surface or ambient temperature, winter formulation or force curing shall be used.
- 11.1.8 Over-coats/topcoats shall be applied within the manufacturer's minimum and maximum recoat times. Dry film thickness of each coating shall be in accordance with the tables.
- 11.1.9 Coating shall be applied using clean equipment.
- 11.1.10 Runs, sags, voids, drips, overspray, loss of adhesion, blistering, peeling, mudcracking, inadequate cure, or rusting of the substrate shall not be permitted.
- 11.1.11 Where shop coating has been damaged in transit or where damage has occurred to field coats, all damaged and loosely adhering coating shall be removed and the surface thoroughly cleaned. Edges of the breaks shall be feathered and the designated number of prime and finish coats applied. The coating shall match the original color and gloss.
- 11.1.12 Items shall be coated in accordance with Appendix B. The color of succeeding coats shall vary slightly from the color of the preceding coat to permit easy identification without affecting finish color. Damaged coatings shall be retouched before succeeding coats are applied. Finish colors shall be in accordance with Appendix C.
- 11.1.13 In addition to coats described in specified systems, a "Stripe Coat" of materials shall be applied to weld seams, bolts, flanged edges and similar areas prior to general application of coating.
- 11.1.14 Paints containing metallic aluminum lead or zinc shall not be used to overcoat stainless steel materials. Also, these paints shall not be applied in proximity to stainless steel where the stainless steel could be contaminated with molten, elemental aluminum, lead, or zinc as a result of welding or fire.
- 11.1.15 Exposed piping, duct work, access panels, grills, and equipment not shop primed and other similar items to be finish coated shall be coated as specified for the particular surface except that the final coat shall match the adjacent structures. The finish coats shall be compatible with the primer used.
- 11.1.16 After assembly of parts, weld seams and other surfaces where primer to topcoats or both have been damaged or omitted shall be prepared and recoated in accordance with this specification.

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	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
 Refinería de Cartagena S.A.		Revision: 7
		Date: 31-Mar-11
		Page: 15 of 28

11.1.17 Coatings to be applied over inorganic zinc primer shall first be applied as a mist coat followed by a full coat of the specified material.

12 INSPECTION AND TESTING

12.1 General Requirements

12.1.1 The following steps shall be subject to inspection by Purchaser's representative:

12.1.2 Following surface preparation and immediately prior to the coating application.

12.1.3 Following the application and curing of each coat.

12.1.4 After final inspection and sign-off, in accordance with the project requirements.

12.1.5 The Seller shall furnish the necessary testing and inspection instruments, properly calibrated and maintained. Such equipment shall be available for use by Purchaser in conducting surveillance of the work.

12.1.6 Prior to using compressed air, the quality of the air downstream of the separator shall be tested in accordance with ASTM D 4285. The test shall be performed at the beginning of each shift and at not less than 4-hour intervals. The test also shall be made after any interruption of the air compressor operation or as required by Purchaser. The air shall be used only if the blotter test indicates no visible contamination, oil, or moisture. If contaminants are evident, the equipment deficiencies shall be corrected and the air stream shall be retested. Separators shall be bled continuously. All lines shall be tested individually prior to use. Surfaces, which are determined to have been blasted or blown down with contaminated air, must be cleaned of that contamination and reblasted with clean air and abrasive.

12.1.7 Any defects disclosed by inspection shall be reinspected after correction.

12.2 Surface Preparation Inspection

12.2.1 The temperature, dew point, and relative humidity shall be determined with a sling psychrometer or equal following procedures in ASTM E 337. Readings are required at the start of work and every four (4) hours or at other time intervals approved in writing by Purchaser. Alternatively, continuous monitoring shall be performed using systems established and/or accepted by Purchaser.

12.2.2 Blast cleaned surfaces shall be compared with SSPC Vis-1 visual standards. The anchor pattern profile depth shall be verified in accordance with ASTM D 4417.

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 	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
		Revision: 7
		Date: 31-Mar-11
		Page: 16 of 28

12.2.3 A grease-free chalk shall be used to mark local areas, which do not meet specified standards.

12.2.4 Recirculated shot and grit used for abrasive cleaning shall be tested for the presence of oil by immersing in water and checking for oil flotation. Tests shall be made at the start of blasting, every four (4) hours thereafter, and at the end of blasting. IF oil is evident, contaminated abrasive shall be replaced with clean abrasive and retested before proceeding. All steel blasted since the last satisfactory test shall be inspected and all contaminated steel shall be reblasted.

12.3 Coating Inspection

12.3.1 Surface temperature and humidity readings shall be taken prior to application of each coat. The work shall not proceed if the ambient temperature parameters are outside the requirements of this Specification. If more stringent, the Coating Manufacturer's requirements shall dictate. The substrate temperature shall be at least 5°F (3°C) above the dew point temperature.

12.3.2 Wet film thickness shall be checked during the application of each coat to assure the specified dry film thickness (DFT) will be met.

12.3.3 The dry film thickness shall be tested with a Mikro-test FIM gauge or an accepted equivalent. The testing method shall be in accordance with SSPC PA-2.

12.3.4 The film shall be visually inspected for defects such as overspray runs, sags, mud cracking, inadequate cure, and lack of adhesion. Mud cracking must be removed by reblasting. The Seller shall repair all defects according to the touch-up and repair procedures accepted by Purchaser.

13 REMEDIAL WORK

13.1 Touch-Up

13.1.1 Coated surface within the scope of this Specification that is damaged during assembly or handling shall be repaired in accordance with procedures accepted by Purchaser.

13.1.2 The surface profile shall be restored to meet the specified surface preparation requirements for cleanliness and profile. The periphery of a damaged area shall be feathered prior to coating application.

13.1.3 Precautions shall be taken to protect adjacent coated areas from damage caused by local abrasive blasting. The use of vacuum blast type equipment will be permitted for abrasive blast cleaning.

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 	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
		Revision: 7
		Date: 31-Mar-11
		Page: 17 of 28

13.1.4 Power tool cleaning shall be done using requirements of SSPC SP-11.

13.1.5 Inorganic zinc primer shall be touched up with organic zinc epoxy for temperature up to 250°F (121°C).

14 ADDITIONAL REQUIREMENTS

14.1.1 All shop coated piping equipment and steel shall be handled using nylon slings or other approved lifting methods. Proper dunnage during transport, storage and job site erection shall be used to minimize damage to the coating. Similar precautions shall be taken on field-coated steel.

 	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
		Revision: 7
		Date: 31-Mar-11
		Page: 18 of 28

15 APPENDICES

15.1 Appendix A - Paint Products

Generic Product	Typical Manufacturer's and Products			
	Ameron	International Paint	Sherwin-Williams	Carboline
Inorganic Zinc (IO Zinc)	Dimetcote 9 Series	Interzinc 22	Zinc Clad II Series	Carbozinc 11 Series
Organic Zinc Epoxy	Amercoat 68HS	Interzinc 52	Zinc Clad IV	Carbozinc 859
HB Epoxy	Amercoat 385	Intergard 475HS	Macropoxy 646	Carboguard 890 Series
Epoxy Primer No Corr Inhibitor	Amercoat 385	Interseal 670 HS	Macropoxy 646	Carboguard 888
Novolac Epoxy	Amercoat 91	Intertherm 228	Phenicon HS	Thermaline 450
Modified Silicone	PSX 892HS	Intertherm 875	SW Hi-Temp 500V	Thermaline 4900 Series
High Heat Silicone	Amercoat 878	Intertherm 50	SW Hi-Temp 1000V	Thermaline 4700 Series
Polyurethane	Amercoat 450HS	Interthane 990	Acrolon 218HS	Carbothane 134 Series
Coal Tar Epoxy	Amercoat 78HB	Intertuf 708	TarGuard	Bitumastic 300M
Epoxy (Coal Tar Free)	Amerlock 2/400 GFK	Interseal 670HS (Black)	Macropoxy 646 (Black)	Carbomastic 18 BT

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 	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
		Revision: 7
		Date: 31-Mar-11
		Page: 19 of 28

15.2 Appendix B - Painting Summary for Equipment, Piping, & Structures

All temperatures noted in this schedule shall be actual operating conditions, not steam out and design conditions. Paint system(s) selection for supports (skirts, pipe hangers, etc.) shall be based on the actual skin temperature during operation. Equipment and piping requiring regeneration shall be painted with coatings having a heat resistance capable of withstanding said conditions. Refractory lined items such as heaters and stacks shall be painted in accordance with calculated cold face temperatures.

PAINTING SUMMARY FOR EQUIPMENT, PIPING & STRUCTURES						
PARA NO.	ITEMS	OPER. TEMP.; °F (°C)	PAINT SYSTEM	SURFACE PREPARATION: SSPC Anchor Profile mils (µm) Primer/Intermediate/Finish Coats DFT: mils (µm)	TOTAL DFT, mils (µm)	REMARK
1.0	STRUCTURAL STEEL					
1.1	Columns, Beams, Girders, Trusses, Channels, Walkways, Handrails, Ladders, Grating and other structural members	ALL		Hot Dipped Galvanized		
1.2	Galvanized Steel to be Covered with Insulation or Cementitious Fireproofing	≤200 (≤93)	9	Pretreat Novolac Epoxy 4.0-6.0 (100-150)	100-150 (4.0-6.0)	
1.3	Non-galvanized structural steel to be painted.	≤200 (≤93)	1	SP 10 1.0-2.0 (25-50) IO Zinc 2.5-3.0 (62-75) HB Epoxy 4.0-6.0 (100-150) Urethane 1.5-2.5 (37-65)	8.0-11.5 (200-290)	
1.4	Misc. shop coated steel which require spot repair	≤200 (≤93)	1A	SP 11 min 1.0 (25) Organic Zinc Epoxy 2.5-3.0 (62-75) HB Epoxy 4.0-6.0 (100-150) Urethane 1.5-2.5 (37-65)	8.0-11.5 (200-290)	

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  Refinería de Cartagena S.A.	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
		Revision: 7
		Date: 31-Mar-11
		Page: 20 of 28

PAINTING SUMMARY FOR EQUIPMENT, PIPING & STRUCTURES						
PARA NO.	ITEMS	OPER. TEMP.; °F (°C)	PAINT SYSTEM	SURFACE PREPARATION: SSPC Anchor Profile mils (µm) Primer/Intermediate/Finish Coats DFT: mils (µm)	TOTAL DFT, mils (µm)	REMARK
1.5	Galvanized Steel for Safety Color; Items such as ladders, cages, platforms, stairways, walkways and handrail assemblies	≤200 (≤93)	10	Pretreat HB Epoxy 4.0-6.0 (100-150) Urethane 1.5-2.5 (37-65)	5.5-8.5 (137-215)	For Safety Color
1.7	Embed Steel, Anchors, Plates, etc.	≤200 (≤93)	11	SP11 min. 25 (1.0) Epoxy Primer 4.0-6.0 (100-150) Epoxy Primer 4.0-6.0 (100-150)	8.0-12.0 (200-300)	
1.8	Module Steel to be Buried Underground	≤200 (≤93)	12	SP 10 min 2.0-3.0 (50-75) Epoxy (Coal Tar <u>or</u> Coal Tar Free) 8.0 (200) Epoxy (Coal Tar <u>or</u> Coal Tar Free) 8.0 (200)	16.0 (400)	
2.0	DRUMS, TOWERS, COLUMNS, EXCHANGERS, AND REACTORS					
2.1	<u>CARBON STEEL AND LOW ALLOY STEEL</u>					
2.1.1	Un-Insulated or Un-Fireproofed Supports, Saddles, Skirts	≤200 (≤93)	1	SP 10 1.0-2.0 (25-50) IO Zinc 2.5-3.0 (62-75) HB Epoxy 4.0-6.0 (100-150) Urethane 1.5-2.5 (37-65)	8.0-11.5 (200-290)	
2.1.2	Un-Insulated	≤200 (≤93)	1	SP 10 1.0-2.0 (25-50) IO Zinc 2.5-3.0 (62-75) HB Epoxy 4.0-6.0 (100-150) Urethane 1.5-2.5 (37-65)	8.0-11.5 (200-290)	
2.1.3	Un-Insulated	>200 to ≤400 (>94 to ≤204)	2	SP 10 1.0-2.0 (25-50) IO Zinc 2.5-3.0 (62-75) Modified Silicone 1.5-2.0 (37-50) Modified Silicone 1.5-2.0 (37-50)	5.5-7.0 (137-175)	
2.1.4	Un-Insulated	>400 to ≤700 (>204 to ≤370)	3	SP 10 1.0-2.0 (25-50) IO Zinc 2.5-3.0 (62-75) High Heat Silicone 1.0-1.5 (25-37) High Heat Silicone 1.0-1.5 (25-37)	4.5-6.0 (112-150)	

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  Refinería de Cartagena S.A.	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
		Revision: 7
		Date: 31-Mar-11
		Page: 21 of 28

PAINTING SUMMARY FOR EQUIPMENT, PIPING & STRUCTURES						
PARA NO.	ITEMS	OPER. TEMP.; °F (°C)	PAINT SYSTEM	SURFACE PREPARATION: SSPC Anchor Profile mils (µm) Primer/Intermediate/Finish Coats DFT: mils (µm)	TOTAL DFT, mils (µm)	REMARK
2.1.5	Un-Insulated	>700 to ≤1000 (>370 to ≤538)	4	SP 10 1.0-2.0 (25-50) High Heat Silicone 1.0-1.5 (25-37) High Heat Silicone 1.0-1.5 (25-37)	2.0-3.0 (50-75)	
2.1.6	Insulated or Fireproofed-Supports, Saddles, Skirts	≥-40 to ≤300 (≥-40 to ≤150)	5	SP 10 1.0-2.0 (25-50) Novolac Epoxy 4.0-6.0 (100-150) Novolac Epoxy 4.0-6.0 (100-150)	8.0-12.0 (200-300)	
2.1.7	Insulated	≥-40 to ≤300 (≥-40 to ≤150)	5	SP 10 1.0-2.0 (25-50) Novolac Epoxy 4.0-6.0 (100-150) Novolac Epoxy 4.0-6.0 (100-150)	8.0-12.0 (200-300)	
2.1.8	Insulated	<-40 and 301 to 750 (<-40 and 151 to 399)	6	SP 10 1.0-2.0 (25-50) IO Zinc 2.5-3.0 (62-75)	2.5-3.0 (62-75)	
		751 to 1000 (400 to 538)	6A	SP 10 1.0-2.0 (25-50) IO Zinc 2.5-3.0 (62-75) High Heat Silicone 1.0-1.5 (25-37)	3.5-4.5 (87 to 112)	
2.1.9	Insulated: Regeneration Normal Operating Temp Regeneration Temp	≤140 (≤60) ≤450 (≤232)	5	SP 10 Novolac Epoxy 4.0-6.0 (100-150) Novolac Epoxy 4.0-6.0 (100-150)	8.0-12.0 (200-300)	
2.1.10	Insulated: Regeneration Normal Operating Temp Regeneration Temp	>141 to ≤450 (>61 to ≤232) ≤1026 (≤552)	4	SP 10 1.0-2.0 (25-50) High Heat Silicone 1.0-1.5 (25-37) High Heat Silicone 1.0-1.5 (25-37)	2.0-3.0 (50-75)	
2.2	<u>STAINLESS STEEL</u>					

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  Refinería de Cartagena S.A.	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
		Revision: 7
		Date: 31-Mar-11
		Page: 22 of 28

PAINTING SUMMARY FOR EQUIPMENT, PIPING & STRUCTURES						
PARA NO.	ITEMS	OPER. TEMP.; °F (°C)	PAINT SYSTEM	SURFACE PREPARATION: SSPC Anchor Profile mils (µm) Primer/Intermediate/Finish Coats DFT: mils (µm)	TOTAL DFT, mils (µm)	REMARK
2.2.1	Insulated	≥-40 to ≤300 (≥-40 to ≤150)	7	SP 7 1.0 min (25 min) Epoxy Primer (no corrosive inhibitor) 4.0-6.0 (100-150)	4.0-6.0 (100-150)	
2.2.2	Un-Insulated and Insulated	<-40 and >300 (<-40 and >150)	None			
2.2.3	For Shipping Protection of Un-Insulated and Insulated	<-40 and >300 (<-40 and >150)	7	SP 7 1.0 min (25 min) Epoxy Primer (no corrosive inhibitor) 4.0-6.0 (100-150)	4.0-6.0 (100-150)	
3.0	PIPING, PIPING SUPPORTS & FITTING					
3.1	<u>CARBON STEEL AND LOW ALLOY STEEL</u>					
3.1.1	Un-Insulated	≤200 (≤93)	1	SP 10 1.0-2.0 (25-50) IO Zinc 2.5-3.0 (62-75) HB Epoxy 4.0-6.0 (100-150) Urethane 1.5-2.5 (37-65)	8.0-11.5 (200-290)	
3.1.2	Un-Insulated	>200 to ≤400 (>94 to ≤204)	2	SP 10 1.0-2.0 (25-50) IO Zinc 2.5-3.0 (62-75) Modified Silicone 1.5-2.0 (37-50) Modified Silicone 1.5-2.0 (37-50)	5.5-7.0 (137-175)	
3.1.3	Un-Insulated	>400 to ≤700 (>204 to ≤370)	3	SP 10 1.0-2.0 (25-50) IO Zinc 2.5-3.0 (62-75) High Heat Silicone 1.0-1.5 (25-37) High Heat Silicone 1.0-1.5 (25-37)	4.5-6.0 (112-150)	
3.1.4	Un-Insulated	>700 to ≤1000 (>370 to ≤538)	4	SP 10 1.0-2.0 (25-50) High Heat Silicone 1.0-1.5 (25-37) High Heat Silicone 1.0-1.5 (25-37)	2.0-3.0 (50-75)	

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  Refinería de Cartagena S.A.	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
		Revision: 7
		Date: 31-Mar-11
		Page: 23 of 28

PAINTING SUMMARY FOR EQUIPMENT, PIPING & STRUCTURES						
PARA NO.	ITEMS	OPER. TEMP.; °F (°C)	PAINT SYSTEM	SURFACE PREPARATION: SSPC Anchor Profile mils (µm) Primer/Intermediate/Finish Coats DFT: mils (µm)	TOTAL DFT, mils (µm)	REMARK
3.1.5	Insulated	≥-40 to ≤300 (≥-40 to ≤150)	5	SP 10 1.0-2.0 (25-50) Novolac Epoxy 4.0-6.0 (100-150) Novolac Epoxy 4.0-6.0 (100-150)	8.0-12.0 (200-300)	
3.1.6	Insulated	<-40 and 301 to 750 (<- 40 and 151 to 399)	6	SP 10 1.0-2.0 (25-50) IO Zinc 2.5-3.0 (62-75)	2.5-3.0 (62-75)	
		751 to 1000 (400 to 538)	6A	SP 10 1.0-2.0 (25-50) IO Zinc 2.5-3.0 (62-75) High Heat Silicone 1.0-1.5 (25-37)	3.5-4.5 (87 to 112)	
3.1.7	Insulated: Regeneration Normal Operating Temp Regeneration Temperature	≤140 (≤60) ≤450 (≤232)	5	SP 10 Novolac Epoxy 4.0-6.0 (100-150) Novolac Epoxy 4.0-6.0 (100-150)	8.0-12.0 (200-300)	
3.1.8	Insulated: Regeneration Normal Operating Temp Regeneration Temperature	>141 to ≤450 (>61 to ≤232) ≤1026 (≤552)	4	SP 10 1.0-2.0 (25-50) High Heat Silicone 1.0-1.5 (25-37) High Heat Silicone 1.0-1.5 (25-37)	2.0-3.0 (50-75)	
3.2	<u>STAINLESS STEEL</u>					
3.2.1	Insulated from -40°F (-40°C) to 300°F (150°C)	≥-40 to ≤300 (≥-40 to ≤150)	7	SP 7 1.0 min (25 min) Epoxy Primer (no corrosive inhibitor) 4.0-6.0 (100-150)	4.0-6.0 (100-150)	
3.2.2	Un-Insulated and Insulated below -40°F (-40°C) and above 300°F (150°C)	<-40 and >300 (<-40 and >150)	None			

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  Refinería de Cartagena S.A.	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
		Revision: 7
		Date: 31-Mar-11
		Page: 24 of 28

PAINTING SUMMARY FOR EQUIPMENT, PIPING & STRUCTURES						
PARA NO.	ITEMS	OPER. TEMP.; °F (°C)	PAINT SYSTEM	SURFACE PREPARATION: SSPC Anchor Profile mils (µm) Primer/Intermediate/Finish Coats DFT: mils (µm)	TOTAL DFT, mils (µm)	REMARK
3.2.3	For Shipping Protection of Un-Insulated and Insulated below – 40°F (–40°C) and above 300°F (150°C)	<-40 and >300 (<-40 and >150)	7	SP 7 1.0 min (25 min) Epoxy Primer (no corrosive inhibitor) 4.0-6.0 (100-150)	4.0-6.0 (100-150)	
4.0	MACHINERY, VALVES, MOTORS & MISCELLANEOUS ITEMS (CARBON STEEL AND LOW ALLOY STEEL)					
4.1	Pumps, Compressors, and Rotating Equipment		8	Manufacturer's Standard Paint System		
4.2	Control Valves, Relief Valves & Shut Off Valves including Actuators		8	Manufacturer's Standard Paint System		
4.3	Electric Motors & Equipment		8	Manufacturer's Standard Paint System		
4.4	Instrument And Control Panels		8	Manufacturer's Standard Paint System		
5.0	TANKS AND SPHERES (Including Shop Fabricated)					
5.1	<u>CARBON STEEL AND LOW ALLOY STEEL</u>					
5.1.1	Un-Insulated	≤200 (≤93)	1	SP 10 1.0-2.0 (25–50) IO Zinc 2.5-3.0 (62-75) HB Epoxy 4.0-6.0 (100-150) Urethane 1.5-2.5 (37-65)	8.0-11.5 (200-290)	
5.1.2	Un-Insulated	>200 to ≤400 (>94 to ≤204)	2	SP 10 1.0-2.0 (25–50) IO Zinc 2.5-3.0 (62-75) Modified Silicone 1.5-2.0 (37-50) Modified Silicone 1.5-2.0 (37-50)	5.5-7.0 (137-175)	
5.1.3	Un-Insulated	>400 to ≤700 (>204 to ≤370)	3	SP 10 1.0-2.0 (25–50) IO Zinc 2.5-3.0 (62-75) High Heat Silicone 1.0-1.5 (25-37) High Heat Silicone 1.0-1.5 (25-37)	4.5-6.0 (112-150)	
5.1.4	Un-Insulated	>700 to ≤1000 (>370 to ≤538)	4	SP 10 1.0-2.0 (25–50) High Heat Silicone 1.0-1.5 (25-37) High Heat Silicone 1.0-1.5 (25-37)	2.0-3.0 (50-75)	

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  Refinería de Cartagena S.A.	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
		Revision: 7
		Date: 31-Mar-11
		Page: 25 of 28

PAINTING SUMMARY FOR EQUIPMENT, PIPING & STRUCTURES						
PARA NO.	ITEMS	OPER. TEMP.; °F (°C)	PAINT SYSTEM	SURFACE PREPARATION: SSPC Anchor Profile mils (µm) Primer/Intermediate/Finish Coats DFT: mils (µm)	TOTAL DFT, mils (µm)	REMARK
5.1.5	Insulated up to 250°F (121°C)	≤250 (≤121)	5	SP 10 1.0-2.0 (25-50) Novolac Epoxy 4.0-6.0 (100-150) Novolac Epoxy 4.0-6.0 (100-150)	8.0-12.0 (200-300)	
5.1.6	Insulated above 250°F (121°C)	>250 to 752 (>121 to 400)	6	SP 10 1.0-2.0 (25-50) IO Zinc 2.5-3.0 (62-75)	2.5-3.0 (62-75)	
5.1.7	Underside of Tank Bottom	≤200 (≤93)	12	SP 10 min 2.0-3.0 (50-75) Epoxy (Coal Tar <u>or</u> Coal Tar Free) 8.0 (200) Epoxy (Coal Tar <u>or</u> Coal Tar Free) 8.0 (200)	16.0 (400)	
5.2	<u>STAINLESS STEEL</u>					
5.2.1	Insulated from -40°F (-40°C) to 300°F (150°C)	≥-40 to ≤300 (≥-40 to ≤150)	7	SP 7 1.0 min (25 min) Epoxy Primer (no corrosive inhibitor) 4.0-6.0 (100-150)	4.0-6.0 (100-150)	
5.2.2	Un-Insulated and Insulated below -40°F (-40°C) and above 300°F (150°C)	<-40 and >300 (<-40 and >150)	None			
5.2.3	For Shipping Protection of Un-Insulated and Insulated below -40°F (-40°C) and above 300°F (150°C)	<-40 and >300 (<-40 and >150)	7	SP 7 1.0 min (25 min) Epoxy Primer (no corrosive inhibitor) 4.0-6.0 (100-150)	4.0-6.0 (100-150)	

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  Refinería de Cartagena S.A.	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
		Revision: 7
		Date: 31-Mar-11
		Page: 26 of 28

PAINTING SUMMARY FOR EQUIPMENT, PIPING & STRUCTURES						
PARA NO.	ITEMS	OPER. TEMP.; °F (°C)	PAINT SYSTEM	SURFACE PREPARATION: SSPC Anchor Profile mils (µm) Primer/Intermediate/Finish Coats DFT: mils (µm)	TOTAL DFT, mils (µm)	REMARK
6.0	FURNACES, STACKS, BREECHING, DUCTS, AND BOILERS (Carbon Steel and Low Alloy Steel)					
6.1	Un-Insulated to 400°F (204°C): Furnaces and Boilers	≤400 (≤204)	2	SP 10 1.0-2.0 (25-50) IO Zinc 2.5-3.0 (62-75) Modified Silicone 1.5-2.0 (37-50) Modified Silicone 1.5-2.0 (37-50)	5.5-7.0 (137-175)	
6.2	Un-Insulated to 400°F (204°C): Stacks, Breeching, and Ducts	≤400 (≤204)	2	SP 10 1.0-2.0 (25-50) IO Zinc 2.5-3.0 (62-75) Modified Silicone 1.5-2.0 (37-50) Modified Silicone 1.5-2.0 (37-50)	5.5-7.0 (137-175)	
6.3	Un-Insulated 401°F (205°C) to 752°F (400°C)	>400 to ≤752 (>204 to ≤400)	3	SP 10 1.0-2.0 (25-50) IO Zinc 2.5-3.0 (62-75) High Heat Silicone 1.0-1.5 (25-37) High Heat Silicone 1.0-1.5 (25-37)	4.5-6.0 (112-150)	
6.4	Un-Insulated 753°F (401°C) to 968°F (520°C)	>752 to ≤1000 (>400 to ≤538)	4	SP 10 1.0-2.0 (25-50) High Heat Silicone 1.0-1.5 (25-37) High Heat Silicone 1.0-1.5 (25-37)	2.0-3.0 (50-75)	
6.5	Insulated to 752°F (400°C)	≤752 (≤400)	6	SP 10 1.0-2.0 (25-50) IO Zinc 2.5-3.0 (62-75)	2.5-3.0 (62-75)	
7.0	UNDERGROUND PIPING	Coat and Wrap Coating per Project Specification 166000-000-SP-MU10-0022; Underground Coating Specification.				
8.0	BUILDINGS	See Architectural Specifications				

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  Refinería de Cartagena S.A.	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
		Revision: 7
		Date: 31-Mar-11
		Page: 27 of 28

15.3 Appendix C - Final Coat Colors for Piping

ITEM	DESCRIPTION	FINAL COLOR
Vessels, Exchangers & Piping (To 400 °F (204 °C))	Uninsulated Surfaces	Medium Gray (RAL 7004)
Vessels, Exchangers & Piping (Above 400 °F (204 °C))	Uninsulated Surfaces	Aluminum (RAL 9006)
Direct Fired Heaters, Stacks	Outside Casing	Dark Gray (RAL 7031) or Black (RAL 9017)
Spheres and Storage Tanks	Uninsulated Surfaces	White (RAL 9003)
Cooler Boxes	Uninsulated Surfaces	Medium Gray (RAL 7004)
Structural Steel, including Piping Hangers	Non-galvanized Surfaces	Brown (RAL 8004)
	Stumbling and Tripping Hazards	OSHA Safety Yellow (RAL 1018)
Machinery	Uninsulated	Manufacturer's Standard Color or Medium Gray (RAL 7004)
Electrical	Equipment and Light Poles	Aluminum (RAL 9006)
Fire Fighting System	Fire Fighting Equipment, Hydrants, Monitors, Hose Reels, Firewater Pumps, Firewater Lines	OSHA Safety Red (RAL 2002)
Safety Equipment	Safety Showers, Eye Wash Fountains	OSHA Safety Green (RAL 6002)
Tanks, Equipment and Piping	Buried	Black (RAL 9017)

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 	COATING SPECIFICATION	Document No.: 000-SP-MU10-0017
		Revision: 7
		Date: 31-Mar-11
		Page: 28 of 28

15.4 Appendix D - Paint Codes Requirement for Attachments, Flanges and Valves

FOR PAINT CODE SHOWN IN LINE LIST / ISOMETRICS, THE REQUIRED PAINT CODE REQUIREMENT FOR "ATTACHMENTS", FLANGES AND VALVES" IS SHOWN BELOW.

PAINT CODE PER LINE LIST / ISOMETRICS	PAINT CODE FOR ATTACHMENTS, FLANGES AND VALVES
1	1
2	2
3	3
4	4
5	2
6	3
6A	4
7	7

* ATTACHMENTS INCLUDE PIPE SHOES, LUGS, PIPE SUPPORTS, AND TRUNNIONS.