

SECTION 09 96 00 - CORROSION CONTROL COATINGS

1.01 ^{A7}SUMMARY:^{A7}

- A. ^{A5}**Scope:** This Section contains the performance and prescriptive specifications for corrosion-control coatings for metals used in equipment, buildings and other structures of the locks,^{A5 A11} including all hydraulic structures such as lock gates, trackway, culvert valves, conduit valves, **bulkheads**, **closures** for culverts and gate-Recesses, and other underwater metals. Hydraulic structures coated in accordance with this Section shall be provided with cathodic protection in accordance with Section 26 42 00 (*Cathodic Protection*). Hydraulic structures that cannot be effectively protected by galvanic cathodic protection shall be protected in accordance with Section 05 50 13.13 (Metallizing and Coating Hydraulic Structures).^{A11 A5} This Section covers factory- or field-applied coatings intended to provide corrosion protection for metals in the lock facilities.^{A5 A11} (Deleted text)^{A11 A10} This Section also covers the corrosion control coating requirements for the existing Miraflores Swing Bridge and viaduct, applicable only if these structures will be used by the Contractor in accordance with Section 34 01 43.71 (*Miraflores Swing Bridge and Access*).^{A10}

B. **Related Sections:**

01 35 23	<i>Health and Safety Requirements</i>
05 50 13.13	<i>Metallizing and Coating Hydraulic Structures</i>

1.02 **REFERENCES:**

A. **American Institute of Steel Construction (AISC) Publications:**

325-05	LRFD Manual of Steel Construction
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B. **American Society for Testing and Materials (ASTM) International Standards:**

B 117-07	Practice for Operating Salt Spray (Fog) Testing Apparatus
D 344-04	Relative Hiding Power of Paints by the Visual Examination of Brushouts.
D 522-01	Mandrel Bend Test of Attached Organic Coatings
D 660-05	Evaluating Degree of Checking of Exterior Paints
D 661-05	Evaluating Degree of Cracking of Exterior Paints
D 714-06	Evaluating Degree of Blistering of Exterior Paints
D 772-05	Evaluating Degree of Flaking (Scaling) of Exterior Paints
D 867-81(86)	Pumice Pigment
D 870-02	Water Resistance of Coatings Using Water Immersion
D 1653-03	Water Vapor Transmission of Organic Coating Films

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| D 2197-04 | Adhesion of Organic coatings by Scrape Adhesion |
| D 2247-02 | Water Resistance of Coatings in 100% Relative Humidity |
| D 2583-07 | Indentation Hardness of Rigid Plastics by Means of Barcol Impressor |
| D 2794-04 | Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact) |
| D 3273-05 | Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber |
| D 3359-02 | Measuring Adhesion by Tape Test |
| D 3363-05 | Film Hardness by Pencil Test |
| D 4060-07 | Abrasion Resistance of Organic Coatings by the Taber Abrasive |
| D 4214-07 | Evaluating Degree of Chalking of Exterior Paint Films |
| D 4417-03 | Field Measurement of Surface Profile of Blast Cleaned Steel |
| D 4541-02 | Pull-off Strength of Coatings Using Portable Adhesion Testers |
| D 5162-01 | Discontinuity (Holiday) Testing of Nonconductive Protective Coatings on Metallic Substrates |
| E 84-07 | Surface Burning Characteristics of Building Materials |
| E 96/E 96M-05 | Water Vapor Transmission of Materials |
| G 8-03 | Cathodic Disbonding of Pipeline Coatings |
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C. National Association of Corrosion Engineers (NACE) Standard: | |
| RP 0188-1990 | Discontinuity (Holiday) Testing of Protective Coatings |
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D. National Electrical Manufacturers Association (NEMA) Standard: | |
| Z535.1-2006 | Safety Color Code |
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E. National Fire Protection Association (NFPA) Code: | |
| 101-06 | Life Safety Code |
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F. National Sanitation Foundation (NSF) Standard: | |
| NSF/ANSI 61-07 | Drinking Water System Components – Health Effects |
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G. Steel Structures Painting Council (SSPC) Publications: | |
| | Steel Structures Painting Manual, Volume 2, Systems and Specifications, Seventh Edition: 1995 |

PA 2-04	Paint Application Specification No. 2 Measurement of Dry Paint Thickness with Magnetic Gages (Steel Structures Painting Manual, Ch 5 - Paint application Specs)
97-07	The Inspection of Coatings and Linings, a Handbook of Basic Practice for Inspectors, Owners, and Specifiers.
Vis 1-02	Visual Standard for Abrasive Blast Cleaned Steel (Standard Reference Photographs)

1.03 ^{A7}REQUIREMENTS:^{A7}

- A. **Corrosion Protection Requirements:** Design and apply corrosion control coatings that will protect metal surfaces from corrosion and deterioration caused by the environment and service.
1. For exterior atmospheric service, use coatings appropriate for a tropical coastal marine environment, which shall as a minimum withstand 2,000 hours without corrosion in salt spray cabinet as tested in accordance with ASTM B 117.
 2. Use preconstruction primers or primer coatings which will minimize undercutting corrosion.
 3. Use coating systems with sufficient number of coats to minimize direct contact of the substrate with the environment.
- B. **Adherence Requirements:** Design corrosion control coating systems that will comply with the following adherence requirements:
1. Adhesion to the metal surfaces shall be minimum 3,447 kPa on steel surfaces except that for surfaces subject to foot or wheel traffic, adhesion shall be minimum 4,826 kPa, as measured in accordance with ASTM D 2197. Intercoat adhesion shall be not less than 2,068 kPa, as measured in accordance with ASTM D 2197. Where field adhesion testing is required, tests shall be in accordance with ASTM D 4541.
 2. At faying surfaces of bolted structural joints, friction type slip-critical connections, use coatings which are approved for such use by AISC 325.
 3. Schedule and apply coatings to avoid any type of surface contamination, including salts, water, dust, oil or grease, which may affect adherence of the coatings. Where such contamination is suspected, adhesion of thin coating systems shall be tested by the tape test, in accordance with ASTM D 3359.
 4. Compatibility between coats of different materials. In general, primers, intermediate coats and finish coats shall be compatible products from the same manufacturer. Products from different manufacturers shall be patch tested for compatibility.
 5. After application, coatings shall not show any adhesion-related failures such as blisters, peeling or flaking or intercoat delamination. Applied coatings shall not

show visible evidence of entrapped solvents or humidity between the substrate and primer or between coats. Blistering shall be evaluated in accordance with ASTM D 714. Flaking shall be evaluated in accordance with ASTM D 772.

6. Coatings for underwater and underground service, and in general coatings for structural metals shall be applied on surfaces with a surface anchor profile as recommended by the coating system manufacturer. Surface anchor profile of blast cleaned surfaces shall not be smaller than 50 microns as measured in accordance with ASTM D 4417. Surfaces requiring abrasive blast cleaning shall be cleaned to degree specified in accordance with the corresponding surface preparation specification and visual standard SSPC Vis 1.
- C. **Integrity Requirements:** Finished coatings shall be free from mudcracking, wrinkling, cracking, chalking and other coating failures or deterioration. Use surface preparation, pretreatment, primers, intermediate coats, and finish coats that will, as a system, meet the requirements for the environment and service.
- D. **Thickness Requirements:** Coating Thickness shall be appropriate for the environment and service. Coatings for underground and underwater service shall be minimum 0.508 mm thick.
- E. **Chemical Resistance Requirements:** Provide coatings with chemical resistance adequate for the environment in which the metal is to perform its service. As a minimum, corrosion control coatings shall be resistant to:
1. Acids from acid rain or fog which may form from electrical thermal generation, vehicular and ship exhaust.
 2. Alkalies from salts in the coastal environment
 3. Coatings used in areas where fuels and oils, grease or other lubricants are used and may be subject to splash or spillage shall be resistant to hydrocarbons.
 4. Coatings used in tank interiors shall be resistant to continuous immersion in the type of liquids contained.
 5. Coatings used on zinc, galvanized steel, or aluminum shall have adequate adhesion on such surfaces, and shall not be subject to saponification.
 6. Coatings subject to cathodic protection shall have excellent alkali resistance and excellent resistance to cathodic disbondment, as measured in accordance with ASTM G 8.
 7. Coatings subject to solvent splash or spillage of solvents, or to cleaning with solvents, shall have a high solvent resistance.

F. Water Resistance Requirements:

1. Design and apply corrosion control coatings that will be impermeable, resistant to rain water, and low pressure water cleaning at 1,724 kPa.
2. The finish shall allow free drainage of water to minimize time of wetness.
3. Coatings shall have low water permeability. Water vapor transmission rate shall not exceed 0.25 perms when tested in accordance with ASTM D 1653.
4. Coatings shall have an excellent humidity resistance, as tested by either humidity cabinet in accordance with ASTM D 2247.
5. Coatings used on underground or underwater steel shall be suitable for continuous immersion in fresh or salt water, shall be resistant to ionic passage, moisture vapor transfer, and to osmosis. Water immersion resistance shall be no less than 3,000 hours as tested in accordance with ASTM D 870.

G. Flexibility Requirements:

1. Coatings applied on metals exposed to thermal expansion and contraction, or bending, shall be adequate for such service. Such coatings shall pass the mandrel bend test performed in accordance with ASTM D 522.
2. Coatings used on underground pipes or steel structures shall be resistant to thermal expansion and contraction as well as stresses imposed on the steel surfaces as the soil contracts and expands as water contents varies.
3. Coatings after full cure and exposure to the actual service environment shall show no signs of cracking, as evaluated by ASTM D 661.

H. Temperature Resistance Requirements:

1. Design and apply corrosion control coating systems that will meet performance requirements in the full temperature range of the service environment.
2. Coatings for use on metals which will be at high temperatures shall be adequate for such service. Application and curing of such coatings shall be in accordance with the manufacturer instructions.

I. Fire Resistance Requirements: Coatings applied to structural metal or doors where fire retardance is required by code shall have fire retardance rating, in terms of flame spread, fuel contribution, and smoke density equal to or greater than the NFPA 101 requirement, as tested in accordance with ASTM E 84.

J. Abrasion Resistance Requirements: Floor coatings shall be resistant to the expected foot or wheel traffic.

- K. **Slip Resistance Requirements:** Floor coatings on metal stairs steps and landings, and horizontal covers at floor level shall contain non-skid pigments to produce slip resistance for pedestrians. Non skid pigments conforming to ASTM D 867 shall be added to the coating material in a proportion recommended by the coating manufacturer.
- L. **Hardness Requirements:**
1. Each coating system after full cure shall have sufficient hardness to sustain its integrity under the expected service and operational environment.
 2. The hardness shall not be less than that stated in the manufacturer technical documentation, as measured by the pencil hardness test per ASTM D 3363 or the Barcol hardness test per ASTM D 2583.
 3. For coatings where abrasion is a concern, the hardness shall not be less than that stated in the manufacturer technical documentation as measured by the Taber wheel abrasion test per ASTM D 4060.
- M. **Impact Resistance Requirements:** Coatings that will be subject to impact shall pass ASTM D 2794.
- N. **Durability Requirements:** Design and apply corrosion control coatings that have a service life of minimum 7 years without maintenance, in the environment in which the metal will function.
1. **Weathering:** Design and apply coatings that have superior weathering resistance, and resistance to degradation from ultraviolet radiation.
 2. Apply coatings on metal surfaces that have been properly prepared, to the degree specified, in accordance with the surface preparation standards found in the SSPC Steel Structures Painting Manual, Systems and Specifications:
 - a. SSPC SP1 Solvent Cleaning
 - b. SSPC SP2 Hand Tool Cleaning
 - c. SSPC SP3 Power Tool Cleaning
 - d. SSPC SP5 White Metal Cleaning
 - e. SSPC SP6 Commercial Blast Cleaning
 - f. SSPC SP7 Brush-off Blast Cleaning
 - g. SSPC SP10 Near White Metal Cleaning
 - h. SSPC SP11 Power Tool Cleaning to Bare Metal
 - i. SSPC SP12 High and Ultra-High Water Jetting
- O. **Biological Resistance Requirements:** Design and apply corrosion control coatings that are resistant to bacteria, fungus, and other forms of biological attack, leading to premature coating breakdown.

1. Fungicides shall not be in the ACP prohibited substances list included in Section 01 35 23 (*Health and Safety Requirements*), and shall be the type and quantity recommended by the coatings manufacturer. Resistance to growth of mold on the coating surface shall be high, as tested in accordance with ASTM D 3273.
2. Coatings for underground pipes and steel structures shall be resistant to biological attack by sulfate reducing bacteria or fungus.

P. Uniformity Requirements:

1. Apply corrosion control coatings in such a manner as to produce a protective, continuous film of uniform thickness and consistency.
2. Exposed metal surfaces of items which are galvanized, where the galvanizing has been removed for welding purposes, or where the item has been cut exposing non-galvanized surfaces, or where the galvanizing has been damaged for any reason, shall be repaired by coating with a suitable cold galvanizing compound of minimum 95% zinc content in the dry film. The cold galvanizing coating shall be of a thickness comparable to the adjacent, galvanized surfaces.

Q. Service Life: Design and apply corrosion control coatings which will extend the service life of the metal items with minimum maintenance.

1. Coatings for hydraulic structures shall have a minimum service life of 20 years, in complete or intermittent immersion in fresh, brackish or salt water, and in exterior, atmospheric exposure in the Splash Zone, in a tropical, coastal marine environment.
2. Coatings for metal structures which are not hydraulic structures shall have a minimum service life of 7 years for exterior, atmospheric exposure in a tropical, coastal marine environment.
3. Coatings for metal structures which are not hydraulic structures shall have a minimum service life of 20 years for continuous underwater immersion exposure in fresh and salt water and for intermittent underwater immersion exposure in fresh and salt water.
4. Coatings for metal structures which are not hydraulic structures shall have a minimum service life of 30 years for underground exposure in trenches with proper backfill.

R. Dielectric Strength Requirements:

1. Coatings for continuous underwater service, or for underground service, or for use in tidal areas or Splash Zone areas, with or without cathodic protection shall have a high dielectric strength and shall be free from porosity or holidays (an area left uncovered during the application of paint) as tested in accordance with NACE RP 0188 and ASTM D 5162.

S. **Appearance Requirements:**

1. Finished coatings shall not show evident contamination by dust or abrasives, brush marks or fibers, runs or sags, dry overspray, holidays or missed spots, spattering or cratering.
2. Corners and edges, welds, plate overlaps, hardware, and other irregular surfaces shall show complete covering by coatings.
3. Finished coatings shall be free from pinpoint rusting, checking, discoloration, chalking and other coating failures. Chalking shall be evaluated in accordance with ASTM D 4214. Checking shall be evaluated in accordance with ASTM D 660.

T. **Health and Environmental Protection Requirements:** Design corrosion control coating systems that will minimize impact on health and the environment.

1. **Solvents:** Use high build, high solids coatings or solventless coatings that will emit only small quantities of solvents to the atmospheres. Do not use coating solvents or cleaning solvents which are in the ACP Prohibited Substances List included in Section 01 35 23 (*Health and Safety Requirements*).
2. **Contents:** Use coatings which do not have ingredients which are considered carcinogenic or hazardous to human health or the environment. Do not use coatings that contain lead and other heavy metals. Do not use coating materials that when removed would be considered hazardous waste.
3. **Safety Requirements:** Use cleaning and coating materials which do not have contents hazardous to health and are not in the ACP Prohibited Substances List included in Section 01 35 23 (*Health and Safety Requirements*).
4. Where in contact with potable drinking water, use coatings that are NSF 61 compliant.

U. **Maintenance Requirements:**

1. Design and apply coating finishes that will prevent dirt pickup and that may be low pressure water washed without damaging the coating.
2. Use coatings which may be touch-up repaired without requiring complete removal or complicated surface preparation.
3. Standardize corrosion control coatings systems for metal items in the same environment and service. Where possible, use the same corrosion control coating system in both Locks Complexes.

V. **Color Requirements:** Colors shall be as approved by the Employer's Representative. Color designation used for safety purposes shall be in accordance with NEMA Z535.1.

1. For corrosion protection of metals in exterior locations, design and apply coating finishes that will retain color and gloss during its required service life.
2. Design and apply coating finish materials with complete hiding characteristics. If required, hiding shall be evaluated in accordance with ASTM D 344.

1.04 ^{A7}DESIGN CRITERIA/SYSTEM DESCRIPTION AND PERFORMANCE:^{A7}

A. General Requirements:

1. **Coating System:** A coating system for corrosion protection of each metal surface shall be designed considering the service environment, work site environment, and operating environment. In general, select a generic coating material that has superior performance for the service and operating environment, with proven record of such performance and industry-wide acceptance.
2. Coating System shall include metal substrate surface preparation, coating schedule (preconstruction primer or pretreatment, primer coat, intermediate coats, and finish coats), individual coating thickness and overall thickness. Coating thickness shall be as measured by SSPC PA 2.
3. **Coating Substrates:** Except for stainless steel and steel protected by embedment in concrete, all metals shall be protected against corrosion by suitable protective coatings.
4. Factory-applied coatings shall meet the requirements of this specification. The Contractor shall perform touch-ups or repair of damaged coating areas with identical coating material.
5. An impermeable coating with high dielectric strength shall be applied on the contact surfaces between:
 - a. Aluminum and concrete
 - b. Dissimilar metals
 - c. Metal surfaces in contact with porous materials

B. Metal surface preparation and coating materials application shall be in accordance with manufacturer instructions.

C. Protection of metals prior to coating:

1. Metals to be painted shall be protected from corrosion by the environment until such time as the metal surface is completely protected by the approved coating system.
2. Protection from corrosion by the environment shall include protection by shelter, adequate storage provisions, or other covering of the metals from rain, dew, other sources of moisture, soil, dust, dirt, or salts in the wind, which may injure the metal during its temporary storage prior to construction, installation, and painting. Surfaces that have been cleaned, pretreated, or otherwise prepared for painting shall be given a coat of the specified first-coat material as soon as practicable after such

preparation has been completed; but in any event, prior to any deterioration of the prepared surface.

3. Hand and power tools and blast cleaning abrasives used for metal substrate surface preparation shall not leave incrustations or embedded materials that may lead to dissimilar metal corrosion, or surface contamination that may cause improper adherence of the primer or first applied coat.

1.05 ^{A7}SUBMITTALS:^{A7}

A. Intermediate Design:

1. **Coating Systems:** For each different type of coating system to be used, the Contractor shall submit a coating system schedule identifying the surfaces to be coated and specifying the level of surface preparation and proposed coating schedule. The schedule shall include the color and dry film thickness of each coating.
2. ^{A7}**Documentation:**^{A7} The Contractor shall submit descriptive literature and technical data and application instructions for each type of material, including blasting abrasive material, solvents, primers, and coatings proposed for use on the project, with its batch number and date of manufacture, and an updated copy of its "MATERIAL SAFETY DATA SHEET" (form OSHA-174). Technical data shall include the ASTM laboratory test methods and corresponding results.

B Before Issuance of the Taking-Over Certificate:

1. **Maintenance Manuals:** The Contractor shall submit maintenance manuals for each type of corrosion coating system that has been applied, indicating detailed procedures for repair and maintenance of the coating systems, including surface preparation and coating material application.
2. **Inspection and Test Reports:** The Contractor shall submit a certified copy of inspection and test reports demonstrating that the corrosion control coating systems have been properly applied in accordance with the schedule and the manufacturer instructions.

1.06 ^{A7}QUALITY ASSURANCE:^{A7}

- A. ^{A5}The quality-assurance inspections, to be carried out by the Contractor, shall be performed by personnel certified by the SSPC (Society for Protective Coatings) or an approved equivalent organization.^{A5}
- B. ^{A5}The quality-assurance inspections, to be carried out by the Contractor, shall be performed by coatings inspectors certified by NACE or an approved equivalent organization.^{A5}
- C. In general, field testing shall be minimized. Testing, if required, shall be performed by qualified laboratories. Laboratory testing results printed in the commercial product

technical documentation and/or certified by the coating manufacturer shall be accepted in lieu of field testing.

- D. Inspection of work under this Section shall in general be done in accordance with SSPC handbook, "The Inspection of Coatings and Linings".
- E. Non destructive tests shall be preferred to destructive tests. Where destructive tests are performed, the Contractor shall repair the damaged area in a manner consistent with the original coating system requirements.

END OF SECTION

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