

SSPC: The Society for Protective Coatings

SSPC-PA 1

SHOP, FIELD, AND MAINTENANCE COATING OF METALS

1. SCOPE

1.1 This standard provides basic requirements for best practices for application of industrial/marine protective coatings to coated or uncoated metallic substrates, and is intended for use by both specifiers and contractors, either in its entirety or by referencing specific sections. It focuses on the coating application process and application-related items that are included as one element of the contractor's work plan or process control procedures. The scope of this standard includes specific as well as general requirements for the application of liquid coatings applied by brush, spray, or roller. Detailed descriptions of site preparation, surface preparation, pretreatments, or selection of primers and finish coats are beyond the scope of this standard. Appendix A provides additional information about the value and use of project-specific contractor work plans. Appendix B provides an example of language that can be used in procurement/specification documents to specify compliance with requirements of SSPC-PA 1. Appendix C provides a list of additional SSPC reference materials.

2. CONTENTS

1. Scope
2. Contents
3. Referenced Standards
4. Definitions
5. Requirements for Handling and Storage of Coating
6. Requirements to Address Before Coating Application
7. General Requirements for Application of Coatings
8. Requirements for Brush, Roll, and Spray Application
9. Requirements for Shop Coating
10. Requirements for Field Coating
11. Repair of Existing Damaged Coatings
12. Curing and Handling of Applied Coatings
13. Inspection Requirements
14. Disclaimer
15. Notes

3. REFERENCED STANDARDS

3.1 The latest issue, amendment, or revision of the referenced documents in effect at the time of publication of this standard is shown below and shall govern unless otherwise specified. Items preceded by an asterisk (*) are referenced in the Notes and are not requirements of the standard.

3.2 If there is a conflict between the requirements of any of the cited reference documents and this standard, the requirements of this standard shall prevail.

3.3 SSPC DOCUMENTS:

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| PA 2 (2015) | Determining Compliance to Dry Coating Thickness Requirements |
| PA 17 (2012) | Determining Compliance to Steel Profile Requirements |
| Guide 12 (1998) | Guide for Illumination of Industrial Painting Projects |
| Guide for Planning Coatings Inspection | |

3.4 AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) STANDARDS:¹

- | | |
|------------------------|---|
| D16 (2014) | Standard Terminology for Paint, Related Coatings, Materials, and Applications |
| D660-93 (2011) | Standard Test Method for Evaluating Degree of Checking of Exterior Paints |
| D714-02 (2009) | Standard Test Method for Evaluating Degree of Blistering of Paints |
| D4285-83 (2012) | Method for Indicating Oil or Water in Compressed Air |
| E337-15 | Standard Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures) |

3.5 NACE INTERNATIONAL STANDARD:²

- * **SP0178 (2007)** Fabrication Details, Surface Finishing Requirements, and Proper Design Considerations for Tanks and Vessels to be Lined for Immersion Service

4. DEFINITIONS

BLISTERING: Formation of dome-shaped projections (blisters) in paints or varnish films resulting from local loss of adhesion and lifting of the film from an underlying paint film

¹ ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959. For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

² NACE International, 15835 Park Ten Place, Houston, Texas 77084. Phone 281-228-6200. <<http://www.nace.org>>

(intercoat blistering) or the base substrate. The standard test method for evaluating the degree of blistering of paints is described in ASTM D 714.

CHECKING: Fine cracking that develops in paint films during prolonged curing or weathering which does not penetrate to the underlying surface.

DEFECT: A surface or film imperfection (flaw), deficiency, or incompleteness that deviates from a specification or industry-accepted condition.

DRIP: A drop of wet coating that forms on or falls from the edge of the coated substrate.

DRY SPRAY: A rough, powdery, non-coherent film produced when an atomized coating partially dries before reaching the intended surface.

FIELD COATING: The on-site coating of new or previously coated metallic substrates.

HOLD POINT: Critical point in an operation where the process is stopped until the work completed to date has been evaluated against the project specification or work standard.

HOLIDAY: An unintentional void in a coating.

INDUCTION TIME: Sometimes called "sweat-in time," the time interval that must elapse after combining the mixed components of multi-component paint before satisfactory application can begin.

MAINTENANCE PAINTING: (1) In broad terms, all painting on industrial structures conducted for protection or aesthetics; (2) Any coating work conducted subsequent to the coating work associated with construction to ensure continuous protection of coated surfaces.

MANUFACTURER'S INSTRUCTIONS AND RECOMMENDATIONS: These (or similar terms such as Product Data Sheet) are used to refer to an equipment supplier's or coating manufacturer's latest published or written instructions and recommendations. Approval of these recommendations shall be obtained from the facility owner or authorized representative. Oral recommendations or instructions from an equipment or coating manufacturer are not acceptable unless backed up in writing by the manufacturer's technical staff.

PAINT: Any pigmented liquid, liquefiable, or mastic composition designed for application to a substrate in a thin layer that is converted to an opaque solid film after application. Used for protection, decoration, identification, or to serve some other functional purposes.

PINHOLE: A holiday or discontinuity that extends entirely through a coating film, approximately the size of a pin; normally caused by solvent bubbling, moisture, or foreign particles.

POT LIFE: The length of time during which the mixed coating can be applied after combining two or more components of a multiple-component coating in accordance with the manufacturer's product data sheet.

PRECONSTRUCTION PRIMER: Thin primer coat for steel components, usually applied in a shop prior to construction of a structure, to provide temporary corrosion control during construction.

PRETREATMENT: (1) Chemical treatment to prepare a bare metal surface for painting; (2) A wash primer, such as vinyl butyral.

PROCESS CONTROL PROCEDURE: A detailed written description of a process to ensure that it is performed and evaluated consistently.

RUNS: Irregularities of a surface due to uneven flow, frequently due to application of a coat that is too heavy and not brushed out well. Also known as "sags" or "curtains."

SAGGING: The irregular downward flow of wet paint under the force of gravity to produce a thicker lower edge.

SHOP COATING: The surface preparation and coating of metallic substrates inside a shop or plant before shipment to the site, or when returned to the shop for refurbishment or repair.

STRIPE COAT: A coat of paint applied to edges, welds, rivet or bolt heads, nuts, rivets and other irregular surfaces on steel structures before or after a full coat is applied to the entire surface. The stripe coat is intended to give those areas sufficient film build to resist corrosion.

TIE COAT: A coating recommended by the manufacturer of a given paint system that creates an effective chemical or adhesive bond between two coats when the recoat window has been exceeded, or is needed to effect positive adhesion of a coating to a known existing coating system.

WORK PLAN: Document containing a list of all actions and procedures that a contractor should perform in logical sequence in order to meet all requirements of the procurement/specification documents.

WRINKLING: A defect that creates small furrows or ridges in a coating film.

5. REQUIREMENTS FOR HANDLING AND STORAGE OF COATING

5.1 All coating shall be delivered to the shop or jobsite in original, unopened containers with labels intact. Minor damage to containers is acceptable provided the container has not been punctured or the lid seal broken. The shipment shall be checked upon receipt to verify that:

- the correct material has been delivered
- the product was shipped in accordance with manufacturer's shipping requirements
- all material is from the same batch, unless otherwise specified

5.2 Each container of coating shall be clearly marked or labeled to show coating identification, date of manufacture, batch number, and other information as needed to meet regulatory requirements. The container label information shall be legible and shall be checked at the time of use to verify that the material's shelf life has not expired.

Each type of coating shall be accompanied by the manufacturer's Safety Data Sheet (SDS) and product data sheet (PDS).

5.3 Coatings shall be stored in original unopened containers in weather-tight spaces where the temperature is maintained between 40 °F and 100 °F (4 °C and 38 °C) unless otherwise recommended in writing by the manufacturer. The coating temperature shall be brought to the manufacturer's

written recommended application temperature before use. (See Note 15.1 for more information on coating storage.)

5.4 Coating shall be used before its shelf life has expired. A coating that has exceeded its shelf life shall not be used unless the contractor or applicator, with permission from the facility owner or authorized representative, has first obtained a certificate of conformance (COC) from the coating manufacturer. The COC shall verify the acceptability of that batch of coating for use for a specified period of time.

5.5 All containers of coating shall remain unopened until required for use. Coating that has livered, gelled, or otherwise deteriorated during storage shall not be used. Thixotropic materials that are within the viscosity range specified on the product data sheet shall be stirred to attain normal consistency.

6. REQUIREMENTS TO ADDRESS BEFORE COATING APPLICATION

6.1 AMBIGUOUS OR CONFLICTING APPLICATION INSTRUCTIONS OR REQUIREMENTS: Items needing clarification such as omissions, discrepancies, apparent errors, or conflicting requirements identified in the procurement/specification documents shall be identified, addressed and resolved prior to beginning the application process. The resolutions shall be documented. See Appendix A for additional information.

6.2 EXEMPT SURFACES: The contractor shall ensure that areas, components and fittings exempt from coating as identified in the procurement/specification documents are noted in any written communication with the application crew. The contractor shall ensure that the areas are protected with materials sufficient to withstand surface preparation and coating operations. If masking instructions are unclear or lacking in the project procurement/specification documents, the contractor shall obtain clarification from the facility owner or authorized representative or those who manage coating projects for the owner or authorized representative. Machine finished or similar surfaces that should not be coated, but do require protection, shall be protected as specified.

6.3 ILLUMINATION: The type of lighting fixtures and the level of illumination of the work area shall comply with the minimum requirements listed in SSPC-Guide 12 for the operation being performed (general work area, surface preparation and coating application, or inspection).

6.4 SURFACE PREPARATION

6.4.1 Immediately prior to coating application, the surface to be coated shall meet the level of cleanliness, surface profile and other surface condition requirements (e.g., grinding of welds and sharp edges) specified in the procurement/specification documents. If surface preparation requirements are not addressed in the procurement/specification documents, the surface shall meet the level of cleanliness and surface profile

requirements stated in the coating manufacturer's written recommendations. Unless otherwise specified by the facility owner or authorized representative, the surface cleanliness and profile shall be within the coating manufacturer's written recommendations for the intended service environment.

If the surface to be coated is degraded or contaminated subsequent to surface preparation and prior to coating, the contractor shall verify that the surface has been restored to the specified condition before coating application (see Note 15.2). When verified in accordance with SSPC-PA 17, the surface profile shall be within the profile range appropriate for the coating as specified in the procurement/specification documents, as shown on the product data sheet, or in the manufacturer's written application instructions.

6.4.2 Previously applied coating shall be roughened prior to overcoating whenever necessary for the development of proper intercoat adhesion (see Section 7.9). If special surface preparation procedures are required before application of field coats, the coating manufacturer's instructions shall be followed.

6.4.3 Weld Preparation: Before applying the coating, verify that all welds and all areas adjacent to welds meet, at minimum, the cleanliness level and profile range specified for the metallic substrate (see Section 7.4 and Note 15.3).

6.5 REQUIRED AMBIENT CONDITIONS

6.5.1 Temperature: The application of a coating system shall occur only when the air and substrate temperatures are within the ranges indicated by the manufacturer's written instructions for both application and curing and can be expected to remain in those ranges. Coatings shall not be applied outside the manufacturer's recommended temperature ranges without the written approval of the manufacturer and the facility owner or authorized representative (see Note 15.4).

6.5.2 Surface Moisture: Unless otherwise specified, or authorized by the facility owner or authorized representative, coating shall not be applied in rain, wind, snow, fog, or mist, or when the metallic substrate's surface temperature is less than 5 °F (3 °C) above the dew point. Coating shall not be applied to wet or damp surfaces unless the coating is formulated and certified by the manufacturer for this type of application. Coating shall not be applied on frosted or ice-coated surfaces.

6.5.3 Humidity: Because curing of coatings may be adversely affected by humidity that is too low or too high, no coating shall be applied unless the manufacturer's written recommendations for the humidity range are met (see Note 15.5).

6.5.4 Wind Speed: Unless otherwise specified by the facility owner or authorized representative, exterior application of paint shall cease when wind velocity reaches 25 miles per hour or more at the point of application, either in gusts or at a steady state (see Note 15.6).

6.6 PROTECTION OF EXPOSED SUBSTRATE FROM WEATHER: If ambient conditions are not suitable for coating application, the metallic substrate shall remain under cover or be protected by enclosure in containment until ambient conditions permit coating application to proceed.

6.7 REQUIRED PRETREATMENT

6.7.1 When specified, the surface shall be pretreated prior to application of the prime coat. The pretreatment shall be compatible with the specified primer as documented by the coating manufacturer.

6.7.2 The provisions of Section 5 and Section 6.4 shall also apply to pretreated surfaces and the materials used for this purpose.

6.7.3 In order to control the degradation or contamination of cleaned surfaces, the pretreatments, or, in the absence of a pretreatment, the prime coat, shall be applied as soon as possible after the surface has been cleaned and before degradation or contamination has occurred. Succeeding coats shall be applied before contamination of any existing coating occurs.

6.7.4 When chemical pretreatments are specified, sufficient time shall elapse between pretreatment and application of the prime coat to permit any chemical reactions to be completed and the surface to dry. Multi-component pretreatments shall be applied within the specified interval after mixing. When pretreatments are used, the instructions of the pretreatment manufacturer shall be followed.

6.7.5 Inhibitive water washes used to prevent rusting of cleaned surfaces prior to coating shall not be considered pretreatments. These shall be used only as specified and only if it is documented by the coating manufacturer that the inhibitor is compatible with the coating to be used and will not have adverse long-term effects on the performance of the coating. When specified, test patches shall be used to check adhesion of the coating prior to coating the entire surface.

6.8 MIXING OF COATING COMPONENTS

6.8.1 Manual mixing shall be limited to mixing/blending of low-viscosity single-component coatings. The coating shall be blended completely to ensure that all elements of the materials are suspended properly in the coating (see Note 15.7). Coating shall be strained or filtered after mixing according to the manufacturer's recommendations, except where application equipment is provided with strainers. Strainers shall be of a size to remove skins and undesirable matter, but not to remove the pigment.

6.8.2 The following are acceptable methods for mixing most single-component coatings:

6.8.2.1 Manual (Hand) Mixing: Most of the vehicle shall be poured off into a clean container. The pigment in the coating

shall be lifted from the bottom of the container with a broad, flat paddle. Lumps shall be broken up, and the pigment shall be thoroughly mixed with the remaining vehicle. The poured-off vehicle shall be returned to the coating with simultaneous stirring, until the composition is uniform.

6.8.2.2 Power Mixing: Power mixing of single-component materials is permitted unless otherwise recommended in product data sheets. Power mixing shall be carried out with a suitable high-torque variable-speed mixer at a sufficient speed to blend the materials. The agitator blade shall be capable of lifting material that dropped out of suspension off the bottom of the container. Care shall be taken to limit the speed to ensure that there is no entrainment or entrapment of air in the coating while ensuring that the blending action is suitable. Mixed coating shall not show evidence of air entrapment. Mixing of solvent-containing coatings in open containers shall be done in a ventilated area away from sparks or flames in accordance with applicable safety regulations.

6.8.3 Where a skin has formed in the container, the skin shall be cut loose from the sides of the container, removed and discarded. If the volume of such skins is visually estimated to be more than 2% of the remaining coating, the coating shall not be used.

6.8.4 Coating shall not be mixed or kept in suspension by means of an air stream bubbling under the coating surface.

6.8.5 Dry pigments that are separately packaged shall be mixed into coatings in such a manner that they are uniformly blended and all particles of the dry powder are wetted by the vehicle.

6.8.6 Multiple-component coatings shall be mixed in the correct proportions in accordance with the coating manufacturer's written recommendations. Proper mix ratio shall be maintained when mixing multi-component coatings to ensure that they are blended properly and achieve a proper cure.

6.8.7 Coating materials shall be pre-mixed prior to catalyzing or introduction into equipment to ensure that the material is homogeneous and all the solids are properly dispersed.

6.8.8 Catalysts, curing agents, or hardeners that are separately packaged shall be added to the base coating only after the latter has been thoroughly mixed. The proper volume of the catalyst shall then be slowly poured into the required volume of base with constant agitation. To avoid mixing incorrect ratios of components, mix only complete kits. Do not pour off liquid that has separated from the pigment and then add the catalyst to the settled pigment to aid mixing. The mixture shall be used within the pot life specified by the manufacturer. Therefore, only enough coating shall be catalyzed for prompt use. Most mixed, catalyzed coatings cannot be stored, and unused portions of these shall be placed in proper storage containers for later appropriate disposal (see Note 15.8).

When specified, special continuous mixing equipment shall be used according to the manufacturer's directions.

6.8.9 Pastes shall be made into coatings in such a manner that the paste shall be uniformly blended and all lumps and particles broken up to form a homogenous coating.

6.8.10 Coating that does not have a limited pot life or does not deteriorate on standing may be mixed at any time before using, but if settling or phase separation has occurred it must be remixed immediately before using.

6.8.11 Coating shall not remain in spray pots, painters' buckets, etc., overnight, but shall be stored in a covered container and remixed before use.

6.9 MANUFACTURER'S REQUIRED INDUCTION TIME AND POT LIFE: The induction time (sometimes called "sweat-in time") and pot life stated on the coating manufacturer's product data sheet must be observed.

6.10 THINNING

6.10.1 Thinning of the coating shall be done in accordance with the manufacturer's product data sheet and only with the approval of the facility owner or authorized representative (see Note 15.9). The use of thinners shall comply with air pollution control regulations. In no case shall more thinner be added than that recommended by the manufacturer's written instructions.

6.10.2 The type and amount of thinner added to the coating shall be in accordance with the coating manufacturer's product data sheets for the specific coating being applied, the prevailing ambient conditions and surface temperature, and local air pollution regulations.

6.10.3 When the use of thinner is permissible, thinner shall be added slowly to the coating during the mixing process. For multi-component coatings, thinner is added to the binder during the mixing process. All thinning shall be done under supervision of a knowledgeable person acquainted with the correct amount and type of thinner to be added to the coating and familiar with pertinent regulations relating to solvent emissions.

6.11 TINTING: When successive coats of coating of the same color have been specified, alternate coats of coating shall be tinted, when practical, to produce enough contrast to indicate complete coverage of the surface. Tinting shall be performed in such a manner that it will not be necessary to tint the final coat. Field tinting shall be done only with coatings of the same type from the same manufacturer. When the coating is the color of the metallic substrate, the first coat to be applied shall be tinted. The tinting material shall be compatible with the coating and not detrimental to its service life. It is suggested that the coating be tinted by the manufacturer and appropriately labeled. Single component coatings to be blended for tinting

shall be thoroughly mixed separately before combining and further mixing. For multiple components, similar components of the two different colors shall be blended together before combining and mixing these blends.

7. GENERAL REQUIREMENTS FOR APPLICATION OF COATINGS

7.1 GENERAL: Coating shall be applied in accordance with the manufacturer's written instructions and the project specification. If there is a conflict between the requirements of the manufacturer and the project specification, the more restrictive requirements shall be used unless an exception is approved by the facility owner or authorized representative prior to beginning the application process.

7.2 NUMBER OF COATS AND TYPE OF COATING: The number of coats, type of coating, and surfaces to be coated are normally specified in the procurement/specification documents. If coating thickness is not specified, the dry film thickness (DFT) shall comply with the coating manufacturer's written recommendations. The coating application shall be scheduled to provide protection to the substrate at all construction stages (see Notes 15.10 and 15.11).

7.3 STRIPE COAT APPLICATION: When stripe coating is specified in the procurement/specification documents, all corners, crevices, rivets, nuts, bolts, welds, and sharp edges shall be stripe coated. Unless otherwise specified or approved by the facility owner, the stripe coat shall be applied by brush before applying a full coat. The stripe coat shall extend a minimum of one inch (2 cm) from the edge it is protecting. The coating manufacturer's recommended recoat windows for the stripe coat and full coat shall be observed (see Note 15.12).

7.4 APPLICATION NEAR AREAS TO BE WELDED: If the coating specified can be damaged by the heat of welding, or will create fumes hazardous to the welder when heated during the welding process, or is detrimental to the welding operation or the finished welds, the metallic substrate shall not be coated within four inches (100 millimeters) of the areas to be welded, except when using inorganic zinc-rich primer, which may be applied to within two inches (50 millimeters) of the weld area.

7.5 APPLICATION CONTINUITY: To the maximum extent practical, each coat shall be applied as a visually continuous film of uniform thickness free of holidays, pinholes, and other defects (including runs, drips, sags, etc.). All thin spots or areas missed in the application shall be recoated and permitted to dry before the next coat of coating is applied.

7.6 DRY FILM THICKNESS (DFT): Unless otherwise specified in the procurement/specification documents, all dry film thickness determinations shall be performed as specified in SSPC-PA 2. If no Coating Thickness Restriction Level is specified, Level 3 shall be the default level.

7.6.1 If not otherwise specified, each applied coat shall be within the range specified for that coat by the product data sheet or procurement/specification documents.

7.6.2 In the event the required minimum thickness is not achieved as specified, additional coats shall be applied in accordance with the procurement/specification documents or the coating manufacturer's instructions until the required thickness is obtained. Inorganic zinc-rich coatings shall not be corrected in this manner unless the manufacturer's instructions specifically permit this practice.

7.7 RECOAT WINDOWS: Each coating layer shall be in a proper state of cure or dryness before the application of the succeeding coat so that it is not adversely affected by topcoating. Consult the coating manufacturer for the appropriate time interval before recoating. When applying multiple coats of two-component thermosetting systems, topcoats shall be applied within the recoat window specified by the manufacturer of the undercoat in order to obtain good intercoat adhesion. If, for any reason, this time period is exceeded, the undercoat surface shall be treated as recommended by its manufacturer before topcoating. Such treatments include mild abrasion, solvent treatment, and use of a tie coat. Remove surface contamination that could affect the adhesion of subsequent coats.

7.8 CONTACT SURFACES: Contact surfaces shall be coated or left uncoated as specified in the procurement/specification documents.

7.8.1 Contact surfaces of members to be joined by high strength bolts in a friction connection (faying surfaces) shall provide the required slip coefficient based on the specified class of slip resistance based on the design criteria. Uncoated faying surfaces shall meet the surface preparation and cleanliness requirements for the specified class and shall be free of oil and grease. If coated faying surfaces are required or permitted, the coating used shall be tested and certified to the required class (see Note 15.13) and shall not exceed the allowable thickness as stated on the Certification. If the coating is thinned, the manufacturer and type of thinner shall be the same type as stated on the Test Certificate. The amount of thinner used should be the same as stated on the Test Certificate; however greater or lesser amounts of thinner may be necessary for proper atomization. The maximum amount of thinner added shall not exceed the manufacturer's instructions. The application to, or removal of, coating from bolt hole interiors is not required unless specified in procurement/specification documents, although overspray coating is frequently present.

7.8.2 Coatings on metallic substrates to be embedded, encased or completely enclosed in concrete shall be compatible with concrete.

7.8.3 The areas to be in contact with wood shall receive the full specified coating system before assembly.

7.9 INACCESSIBLE AREAS: Metallic surfaces that will be inaccessible for coating after assembly or field erection shall receive the full specified coating system before assembly or erection.

7.10 PROTECTION OF COATED SURFACES: Wet coating shall be protected against damage from dust or other detrimental foreign matter as much as is practical.

8. REQUIREMENTS FOR BRUSH, ROLL, AND SPRAY APPLICATION

8.1 GENERAL: Apply the coatings using the application methods recommended by the coating manufacturer and as approved by the facility owner or authorized representative (see Notes 15.14 and 15.15). If a conflict arises between the application recommendations in the product data sheet and those in the procurement/specification documents, the contractor or applicator shall seek written clarification from the owner or authorized representative. This standard contains requirements for application using the most common application methods. Specialized methods such as plural-component spray, dipping, flow coating, electrostatic spray, and fluidized bed application shall be performed by craft workers who have been properly qualified and trained for specialized equipment and application techniques.

Whichever application method is used, the dry film thickness of each coat shall meet the requirement of the procurement/specification documents. If no requirements are provided in the procurement/specification documents, the dry film thickness of each coat shall meet the recommended range on the product data sheet for that coating.

8.2 BRUSH APPLICATION: Brush application of coating shall be in accordance with the following:

8.2.1 Brushes shall be of a style and quality that will enable proper application of coating.

8.2.2 The brushing shall be done so that a smooth coat as uniform in thickness as possible is obtained.

8.2.3 Coating shall be worked into all crevices and corners.

8.2.4 All runs or sags shall be brushed out immediately.

8.2.5 Brush marks and other surface irregularities shall be minimized.

8.3 ROLLER APPLICATION: Roller application shall be in accordance with the following:

8.3.1 Rolling shall be done so that a smooth coat as uniform in thickness as possible is achieved (see Note 15.16).

8.3.2 Roller covers that do not shed fibers into the paint shall be used. The roller cover nap shall be appropriate for the particular surface roughness.

8.3.3 Roller application shall be in accordance with the recommendations of the coating manufacturer and roller manufacturer. Coating rollers shall be of a style and quality that will enable proper application of coating having the continuity and thickness required in Sections 7.5 and 7.6.

8.3.4 Roller application shall not be used on irregular surfaces such as rivets, bolts, crevices, welds, corners, or edges, unless specifically permitted by the procurement/specification documents. If roller application to irregular surfaces is permitted, the coating shall be immediately brushed out to form a continuous and unbroken film (see Note 15.17).

8.4 SPRAY APPLICATION (GENERAL): All spray application of coating shall be in accordance with the following:

8.4.1 The equipment used shall be suitable for the intended purpose, shall be capable of properly atomizing the coating to be applied, and shall be equipped with suitable pressure regulators and gages. The equipment shall be maintained in proper working condition. Spray equipment shall meet the material transfer requirements of the local air pollution or air quality management district.

8.4.2 Spray equipment shall be kept sufficiently clean so that dirt, dried coating, and other foreign materials are not deposited in the coating film. Any solvents left in the equipment shall be completely removed before using.

8.4.3 Coating shall be applied in a uniform layer with overlapping at the edges of the spray pattern. During application, the gun shall be held perpendicular to the surface and at a distance that will ensure that a wet layer of coating is deposited on the surface. The trigger of the gun shall be released at the end of each stroke (see Note 15.18 for possible exceptions).

8.4.4 All runs and sags shall be brushed out immediately where possible. Repairs shall be performed in accordance with the coating manufacturer's written recommendation as approved by the facility owner.

8.4.5 Cracks, crevices, blind areas of all rivets and bolts, and all other inaccessible areas shall be coated by brush or daubers.

8.5 AIR ATOMIZING SPRAY APPLICATION: Compressed air atomizing spray application of coating shall be in accordance with all the provisions of Section 8.4 and in addition shall comply with the following:

8.5.1 Traps or separators shall be provided to remove any oil or condensed water from the air. The traps or separators must be of adequate size and must be bled continuously or drained periodically during operations. The air from the spray gun impinging against a clean surface shall show no condensed water or oil. ASTM D4285 (frequently called the "blotter test")

provides a test procedure for indicating the presence of oil or water in compressed air.

8.5.2 The pressure of the material in the pot and of the air at the gun shall be adjusted for optimum spraying effectiveness. The pressure on the material in the pot shall be adjusted when necessary for changes in elevation of the gun with respect to the elevation of the pot. The atomizing air pressure at the gun shall be high enough to properly atomize the coating, but not so high as to cause excessive fogging of coating, excessive evaporation of solvent or loss by overspray.

8.6 AIRLESS SPRAY APPLICATION: Airless or high pressure spray application of coating shall be in accordance with all of the provisions of Section 8.4 and in addition shall comply with the following:

8.6.1 The orifice size and the fan width of the airless spray tip shall be selected based on the manufacturer's recommendations, site-specific conditions and the configurations of the surfaces being coated.

8.6.2 The air pressure to the coating pump shall be adjusted so that the coating pressure to the gun is proper for optimum spraying effectiveness. This pressure shall be sufficiently high to properly atomize the coating. Pressures considerably higher than those necessary to properly atomize the coating shall not be used.

8.6.3 Spraying equipment shall be kept clean and shall utilize proper filters in the high-pressure line so that dirt, dry coating, and other foreign materials are not deposited in the coating film (see Note 15.19). Any solvents left in the equipment shall be completely removed before applying coating. Observe the coating manufacturer's recommendations regarding proper use of filters.

8.6.4 The trigger of the gun shall be pulled fully open and held fully open during all spraying to ensure proper application of coating. During application, the gun shall be held perpendicular to the surface and at a distance that will ensure that a wet layer of coating is deposited on the surface. The trigger of the gun shall be released at the end of each stroke (see Note 15.18).

8.6.5 Airless coating spray equipment shall always be provided with an electric ground wire in the high-pressure line between the gun and the pumping equipment. Further, the pumping equipment shall be suitably grounded to avoid the build-up of any electrostatic charge on the gun. The manufacturer's instructions are to be followed regarding the proper use of the equipment.

8.7 REPAIR OF APPLICATION-RELATED DEFECTS: Regardless of the application method used, defects in films that are not permitted by the procurement/specification documents, including but not limited to runs, drips, sags, holidays, overspray, or incorrect coating thickness, shall be repaired in

accordance with the coating manufacturer's recommended procedures and shall be approved by the facility owner or authorized representative.

9. REQUIREMENTS FOR SHOP COATING

9.1 APPLICABILITY: All provisions of this standard shall be applicable to shop coating except those under Section 10.

9.2 TOUCH-UP OF SHOP COATED SURFACES: Damage resulting from fabrication, handling, and storage in the shop shall be repaired before leaving the shop. Metal that has been shop-coated shall be touched up with the same coating as the shop coat unless otherwise specified. Inorganic zinc-rich coatings shall not be corrected in this manner unless the manufacturer's instructions specifically permit this practice.

9.3 ERECTION MARKS: Erection and weight marks that need to be visible after erection shall be placed over cured shop-applied coatings unless otherwise specified. Compatible and non-bleeding markers or coating sticks shall be used.

10. REQUIREMENTS FOR FIELD COATING

10.1 APPLICABILITY: All provisions of this standard shall pertain to the field coating of metallic substrates except those in Section 9.

10.2 CURE: Previously applied shop coatings shall be dry or cured sufficiently for overcoating and shall meet project procurement/specification requirements for surface cleanliness and roughening. The manufacturer's instructions shall be followed if special surface preparation procedures are required before application of the field coats.

10.3 COATING COMPATIBILITY: If the field coatings are not specified, the coatings selected shall be compatible with the shop coating and the service environment as determined by the primer manufacturer.

10.4 FIELD COATING PROCEDURES

10.4.1 Touch-Up of Shop Coated Surfaces: Metallic substrates stored pending erection shall be kept free from contact with the ground and positioned to minimize water-holding pockets, soiling, contamination, and deterioration of the coating film. Metallic substrates shall be cleaned and recoated or touched up with the specified coating whenever it becomes necessary to maintain the integrity of the film. Metal that has been shop coated shall be touched up with the same coating as the shop coat unless otherwise specified. Inorganic zinc-rich coatings shall not be corrected in this manner unless the manufacturer's instructions specifically permit this practice.

This touch-up shall include preparing, cleaning and coating of field connections, welds or fasteners, and all damaged or defective coating and rusted areas as specified.

10.4.2 Application of Field Coat: The first field coat shall be applied to shop-coated metallic substrates in a timely manner, as required by the project procurement/specification documents, to protect the metallic substrate from corrosion and to comply with any applicable recoat window for the shop-applied coating. SSPC surface preparation standards require the metallic surface to meet specified cleanliness requirements immediately prior to coating application.

10.4.3 The final coat of coating shall not be applied to metallic substrates until all concrete work in the vicinity is finished. In addition to the cleaning required in Section 10.4.1, all concrete spatter and drippings shall be removed from the metallic substrate before any application of coating. If any coating is damaged due to concrete work, the damaged surface shall be cleaned and recoated before the final coat is applied.

11. REPAIR OF EXISTING DAMAGED COATINGS

11.1 SURFACE PREPARATION FOR RECOATING

11.1.1 Only loose, cracked, brittle, or non-adherent coating shall be removed in cleaning unless otherwise specified. Cleaning shall be performed two inches (50 millimeters) beyond the damaged areas in all directions or until only sound coating remains in the area to be repaired. Where the remaining coating is thick, all exposed edges shall be feathered. Rust spots shall be thoroughly cleaned and the edges of all old coating shall be abraded back to sound material (see Note 15.20).

11.1.2 The contractor shall have the option to remove all coating from large areas containing smaller areas of coating that are required to be removed by the procurement/specification documents.

11.2 INCOMPATIBILITY: Only coatings compatible with the existing coatings and the service environment shall be used. All defects arising from unexpected incompatibility shall be corrected as specified.

12. CURING AND HANDLING OF APPLIED COATINGS

12.1 CURING OF COATINGS

12.1.1 The ambient temperature and humidity as well as minimum and maximum curing times shall conform to manufacturer's written recommendations prior to topcoating. If the maximum cure time is exceeded, the cured coating shall be roughened or otherwise treated as recommended by the manufacturer of the topcoat or overcoat before applying another coat.

12.1.2 No coating shall be force-cured under conditions that will cause checking, wrinkling, blistering, formation of pinholes, or detrimentally affect the protective properties of the coating. Always check with the coating manufacturer before force-curing a coating.

12.1.3 Coating shall be protected from rain, condensation, contamination, snow, and freezing until sufficiently cured for exterior exposure.

12.1.4 No coating shall be subjected to immersion before it is thoroughly cured in accordance with the manufacturer's written recommendations.

12.2 HANDLING OF COATED METALLIC SUBSTRATES

12.2.1 Coated metallic substrates shall not be handled, loaded for shipment, or shipped until the coating has dried except as necessary in turning for coating or stacking for drying.

12.2.2 Coating that is damaged in handling shall be removed and touched up with the same number of coats and kinds of coatings as were previously applied to the metallic substrate or as specified by the procurement/specification documents.

13. INSPECTION REQUIREMENTS

The contractor's work plan (or the inspector's inspection plan) shall include hold points prior to each step of the application as described in the SSPC Guide for Planning Coating Inspection (2008). These include:

- Pre-surface preparation
- Post-surface preparation
- Coating conditions for application
- Coating application
- Post-application of coating
- Post-curing

14. DISCLAIMER

14.1 This is a consensus standard developed by SSPC: The Society for Protective Coatings. While every precaution is taken to ensure that all information furnished in SSPC standards standard is as accurate, complete, and useful as possible, SSPC cannot assume responsibility nor incur any obligation resulting from the use of any materials, coatings, or methods specified herein, or of the standard itself.

14.2 This standard does not attempt to address problems concerning safety associated with its use. The user of this standard, as well as the user of all products or practices described herein, is responsible for instituting appropriate health and safety practices and for ensuring compliance with all governmental regulations.

15. NOTES

Notes are not requirements of this standard.

15.1 It is recommended that coating be stored in a warm building during very cold weather because application will be

easier and thinning the coating prior to application can be avoided. When warming coatings, their temperature should not be permitted to exceed 100 °F (38 °C) unless special coating heating equipment is used. When the coating (or thinner) has a flash point below 100 °F (38 °C) it should not be heated above its flash point if it is heated in an open container.

15.2 Overcoating should be accomplished as soon as possible after curing requirements of undercoats are met. When this is not feasible, the surface should be restored to the cleanliness level required for application of the overcoat. This may require washing or solvent cleaning of the surface to remove soluble contaminants or, if rusting or damage to the coating has occurred, power tool cleaning or blast cleaning and spot repair may be necessary.

15.3 Options for cleaning welds include blast cleaning, power tool cleaning, chemical scrubbing, or water scrubbing to remove detrimental deposits. Chemical or water scrubbing will not provide a profile on the weld. The procurement/specification documents should contain requirements for surface preparation cleanliness level and cleaning method.

For high-performance coating service, special weld surfacing may be required to provide suitable surface conditions for the coating system specified. NACE SP0178 provides one method of specifying weld surfacing requirements, as well as other design and fabrication requirements for improving coating serviceability. Other methods of specifying and accepting weld surfacing conditions are employed in various industries. The weld surfacing requirements are generally placed in the procurement/specification documents so that the painting contractor will not have to perform welding or grinding to provide the specified final surface conditions.

15.4 Cold weather, high humidity, water, fog and mist, and rain during coating application, drying, or curing are detrimental to the performance of most coatings. It is impossible to set down specific rules that govern the limits in which the coating application should be done, since the variation from one coating to another may be large. Generally speaking, application should be done only under conditions that are conducive to quick evaporation of water. This generally means that the relative humidity needs to be low. Metallic substrates should not be coated when it is below the dew point since condensation of water on the metallic substrate will result. The only exception is for coatings that are formulated to tolerate moisture or liquid water on the surface during application

Coatings that dry solely by evaporation of organic solvent are not normally harmed by application to metallic substrates which are below 32 °F (0 °C); however, under such conditions, the danger always exists that there will be a layer of ice on the surface of the metallic substrate. This same condition may prevail for application of conventional, air-oxidizing coatings. When the humidity is low and the metallic substrate is thoroughly dry, coatings may be applied provided they will not be damaged and that drying will not be impaired by low temperature or low humidity.

Generally speaking, coatings should not be applied when ambient conditions will subject them to damage, nor should they be applied when it is expected that the temperature will vary either below or above the temperature range recommended in writing by the manufacturer or drop to freezing before they have cured.

Coatings formulated for application to hot surfaces may not be suitable for application to surfaces below the designed temperature. Conversely, coatings formulated for application at ambient or low temperatures may not be suitable for application to hot surfaces.

Low temperatures greatly reduce the curing rates of chemically cured coatings (certain epoxies, urethanes, inorganic zinc-rich coatings, coal tar epoxies, etc.).

The dew point is the temperature at which moisture from the air will begin to condense. If the surface temperature of the substrate is at the dew point, moisture will condense on it. Dew point may be determined with a sling psychrometer, or other instrument, usually requiring determination of wet and dry bulb temperatures (ASTM E337). Hand-held, digital psychrometers, hygrometers, etc., can make measurement of relative humidity and dew point simple and instantaneous. These electronic instruments can also measure of relative humidity and dew point of a surface that is at a different temperature than the air.

15.5 High humidity may cause moisture to condense on or react with uncured coating films to cause blushing or other adverse effects. However, some coatings such as inorganic zinc and moisture-cured urethane coatings cure by chemically reacting with water, and so require a minimum humidity for complete curing.

15.6 The project specifications may address maximum wind velocity permissible during coating application. A lower velocity may be specified due to individual jobsite conditions and associated safety concerns.

15.7 Power mixing of the components of the coating is preferable to manual (hand) mixing due to the higher viscosity of materials in industrial coatings, particularly where multi-component materials are used. Pigments or solids that inadvertently are not mixed back into the coating may adversely affect the performance of the coating. The coating manufacturer should be consulted for acceptable mixing tolerances.

15.8 Mixing of some coating components can cause a chemical reaction called an “exothermic reaction,” generating heat that can result in expansion of the materials, and a release of vapors or gases that may rupture sealed containers. If exothermic reaction is a possibility, the containers should be vented.

15.9 Coatings to be applied by brush will usually require no thinning. Coatings to be sprayed, if not specifically formulated for spraying, may require thinning when proper adjustment of the spray equipment and air pressure does not result in satisfactory coating application.

Particular care should be observed with respect to type of thinner, amount of thinner, coating temperature, and operating techniques in order to avoid deposition of coating which is too viscous, too dry, or too thin. At very low temperatures, thinners can shock sensitive coating materials, resulting in gelling. It may be necessary to use an approved different coating material or other equipment to resolve these problems.

15.10 Preconstruction primers are usually formulated to provide short-term protection and a good bond between the metallic substrate and subsequent coats. Many preconstruction primers are not intended to provide long-term protection of the metallic substrate, particularly during exposure to dampness, bad weather, and industrial fumes. Between shop application of the primer and field coating application, the metallic substrate is often exposed to the most severe environmental conditions it will ever encounter at a time when it is protected by only one coat of primer. The length of time anticipated between shop application of the primer and the first field-applied coating should be considered when selecting the primer to be used. Long periods of field exposure may degrade the primer so that it may have to receive periodic maintenance to continue to protect the metallic substrate from corrosion and be in a suitable condition for overcoating. When long periods of exposure are anticipated, special consideration should be given to surface preparation, coating selection, film thickness, and to early application of a second primer/overcoat.

15.11 Whenever possible, the last full (finish) coat of coating should be applied after erection of the structure and repair of damaged areas of existing coating. Members may be coated on the ground before erection, provided any damaged coating is touched-up with the same number of coats and kinds of coatings after erection.

15.12 Stripe coating of edges, corners, fasteners, welds, etc., is advantageous in preventing breakdown of coating on such configurations in very corrosive surroundings. Stripe coating is most effective on edges that are prepared by grinding. Tinting of the striping coating is advisable to promote contrast (see Section 7.3). Additional information on stripe coating and edge protection is available in SSPC-PA Guide 11.

15.13 The Specification for Structural Joints Using High-Strength Bolts, published by the Research Council on Structural Connections (RCSC), includes a procedure for determining the slip coefficient of a coating. Most facility owners that have been certified to meet the appropriate slip coefficient requirements.³

15.14 There may be limitations on application techniques based on location and configuration of the facility. For example, spray application may be restricted due to the potential for overspray damage on adjacent surfaces.

³ American Institute of Steel Construction Research Council on Structural Connections, One East Wacker Drive, Suite 700, Chicago, IL 60601-1802. Phone 312-670-5414, <<http://www.boltcouncil.org>

15.15 Coatings on structural metallic substrates are generally applied by brush or by spray. Daubers, natural or synthetic wool mitts, or other applicators may be used for places of difficult access when no other application method is practical. Any of these methods is satisfactory if properly performed and if the coating is formulated for the application method being used. The variations are slight, and often overshadowed by variations in workmanship.

Brushing of primers has the advantage of working coating into cracks and crevices and other surface irregularities. It may, however, create brush marks with coatings having limited leveling.

With many types of coatings, properly used high-pressure spray methods can result in a thicker, more impermeable film. Spray operators must be properly trained. Careful supervision and inspection are necessary with the various spray application methods to prevent encountering such difficulties as dirty surfaces, dry spray, pinholes, holidays, missed areas, blind spots, contamination of coating or air, wind loss, or excessive outdoor overspray.

Several advantages are possible with the various high-pressure airless methods of coating application, both hot and cold spray. These include faster application and a greater thickness per coat than is achieved by conventional air spray. Additional advantages include less, less overspray, reduced power (compressor) requirements, ability to use high-solids coating formulations, and less sensitivity to changes in ambient temperature during application.

Round or oval brushes are generally considered most suitable for rivets, bolts, irregular surfaces, and rough or pitted metallic substrates. Wide, flat brushes are suitable for large flat areas, but they should not have a width over five inches.

15.16 With roller application of coating on structural metallic substrates, high production rates approaching that of conventional spraying may be possible. The method works best on large smooth areas such as tanks or walls, and may be used on flat or slightly curved surfaces. Difficulties may be encountered when coating welds, rough spots, pits, rivet heads or bolt heads, nuts, edges, corners, etc., to ensure that adequate coating is applied. Supplementary brush coating is mandatory for those areas on structural metallic substrates, even though special rollers for these areas are available for general work. The requirements are generally the same as for brush and spray coating. Roller coating is particularly useful where spraying cannot be undertaken due to damage from other hazards.

15.17 In extreme cases, such as work in high-wind areas or when using coatings with very short pot lives, brushing-out may not be feasible. Verify with the coating manufacturer and the owner or authorized representative that sags and runs left in the coating are aesthetically acceptable and will not adversely affect its performance.

15.18 Releasing the trigger at the end of each stroke may

not be possible with some high-solid urethanes, or coatings that have very short cure times or are high-build.

15.19 Excessive filtering can restrict delivery, increase heat, and decrease working time.

15.20 In maintenance coating it is not ordinarily intended that sound and adherent old coating be removed unless it is excessively thick or brittle or is incompatible with the new coating. It is essential, however, that the removal of deteriorated coating be carried back around the edges of the spot or area until an area of completely intact and adherent coating film, with no rust or blisters underneath, is attained. Edges of tightly adherent coating remaining around the area to be recoated must be feathered so that the recoated surface can have a smooth appearance to provide a transition from the area of repair to the intact coating. The remaining old coating should have sufficient adhesion so that it cannot be lifted as a layer by inserting the blade of a dull putty knife under it using moderate pressure.

Unless experience or spot tests have shown otherwise, it is usually preferable to use the same generic type of coating for maintenance recoating as the original coating. If the new coating curls or lifts after application to an existing coating, the cleaning and application procedures should be reviewed to determine if good coating practices have been followed. If the new coating is found to be incompatible with the previous coating system, either the new coating needs be replaced with one more compatible, or the old coating should be completely removed before application of a new system.

Coating records should be kept by the owner or authorized representative for the purpose of determining information on the durability of coatings and the economic protection afforded by them.

APPENDICES

Appendices are not requirements of the PA 1 standard.

APPENDIX A. WORK PLAN: It is strongly recommended that the owner or authorized representative or those who manage coating projects for the owner or authorized representative, require the contractor to submit a detailed, project-specific work plan for the surface preparation and coating application process for review and acceptance by the facility owner or authorized representative prior to project startup. The preparation and use of a contractor work plan has been proven an effective mechanism for project oversight and quality assurance. The contractor's work plan should address key project steps such as mobilization and setup, surface preparation, coating application, coating initial cure, tracking and correction of non-compliant work, and demobilization. PA 1 focuses on the coating application process and application-related items that should be included as one part of the contractor's work plan. Each portion of the work plan will need adjustments for specific projects.

Additional information on the use and benefits of contractor work plans can be found in the following references:

- J. H. Brandon, J.H.; Hames, B; Gorrell, P.G. Use of Work (Quality) Plans on Coatings Projects. SSPC: The Society for Protective Coatings 2003, New Orleans, LA
- J.H. Brandon and M. D. Damiano, "Effective Contract Administration: Key to a Successful Coating Project," JPCL, January 2007, pp. 58-72.
- J. H. Brandon and M. D. Damiano, "Contract Expectations," JPCL, August 2007, pp. 50-60.
- J.H. Brandon and M. D. Damiano, "Surveillance Techniques to Administer Contracts for Procedural Conformity," JPCL, December 2008, pp. 18-33.

APPENDIX B: SAMPLE SPECIFICATION LANGUAGE

Below is an example of language that can be used in procurement documents to specify compliance with requirements of SSPC-PA 1:

Coatings shall be applied in accordance with SSPC-PA 1 with the following exceptions:

[list any exceptions here]

Discrepancies between requirements of procurement documents, product data sheets, and SSPC-PA 1 shall be identified and clarified with the facility owner or authorized representative prior to commencement of work.

APPENDIX C: ADDITIONAL REFERENCE MATERIAL

The standards, reports, and publications listed below are not required as part of the SSPC-PA 1 standard but are recommended resources for additional information.

SSPC-SP COM	Surface Preparation Commentary
SSPC-Paint 15	Steel Joist Shop Primer/Metal Building Primer
SSPC-Paint 16	Coal Tar Epoxy Polyamide Black (or Dark Red) Coating
SSPC-Paint 20	Zinc-Rich Coating (Type I – Inorganic, and Type II – Organic)
SSPC-Paint 23	Latex Primer for Steel Surfaces, Performance Based)
SSPC-Paint 24	Latex Semigloss Exterior Topcoat
SSPC-Paint 27	Basic Zinc Chromate—Vinyl Butyral Wash Primer

SSPC-Paint 29	Zinc Dust Pigmented Primer, Performance-Based
SSPC-Paint 30	Weld-Through Inorganic Zinc Primer
SSPC-Paint 32	Coal Tar Emulsion Coating
SSPC-Paint 33	Coal Tar Mastic, Cold Applied
SSPC-Paint 36	Two-Component Weatherable Aliphatic Polyurethane Topcoat, Performance-Based)
SSPC-Paint 38	Single-Component, Moisture-Cure Weatherable Aliphatic Polyurethane Topcoat, Performance-Based
SSPC-Paint 39	Two-Component Aliphatic Polyurea Topcoat Fast or Moderate Drying, Performance-Based
SSPC-Paint 40	Zinc-Rich Moisture-Cure Polyurethane Primer, Performance-Based
SSPC-Paint 41	Moisture-Cured Polyurethane Primer or Intermediate Coat, Micaceous Iron Oxide Reinforced, Performance-Based
SSPC-Paint 42	Epoxy Polyamide/Polyamidoamine Primer, Performance-Based
SSPC-Paint 43	Direct-to-Metal Aliphatic Polyurea Coating, Performance-Based
SSPC-Paint 44	Liquid-Applied Organic Polymeric Coatings and Linings for Concrete Structures in Municipal Wastewater Facilities, Performance-Based
SSPC-Paint 45	Two-Component, Thick-Film Polyurea and Polyurea/Polyurethane Hybrid Coatings, Performance-Based
SSPC-Paint 46	Elastomeric, Water-Based, High-Build, Flat Performance-Based Coating for Masonry and Concrete
SSPC-PS 12.00	Guide to Zinc-Rich Coating Systems
SSPC-PS 12.01	One-Coat Zinc-Rich Painting System
SSPC-CS 23.00/AWS C2.23M/NACE No. 12	Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for the Corrosion Protection of Steel
SSPC-PS 28.01	Two-Coat Zinc-Rich Polyurethane Primer/Aliphatic Polyurea Topcoat System, Performance-Based
SSPC-PS 28.02	Three-Coat Moisture-Cured Polyurethane Coating System, Performance-Based

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