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SSPC: The Society for Protective Coatings

PAINTING SYSTEM GUIDE NO. 12.00

Guide to Zinc-Rich Coating Systems

1. Scope

1.1 This guide provides general information on the description, selection and application of zinc-rich coatings, and the selection of topcoats.

1.2 Zinc-rich coatings are highly pigmented primer coatings that are uniquely defined by their capability of galvanically protecting steel exposed at discontinuities such as narrow scratches and holidays. While the major pigment component in a zinc-rich coating is zinc dust, the vehicle may be inorganic or organic.

1.3 Zinc-rich coatings are classified as follows:

Type IA—Inorganic - post-cured, water-borne, alkali-silicates
Type IB—Inorganic - self-cured, water-borne, alkali silicates
Type IC—Inorganic - self-cured, solvent-borne, alkyl silicates
Type IIA—Organic - thermoplastic binders
Type IIB—Organic - thermoset binders

1.4 Certain zinc-rich coating systems are suitable for use in protecting steel surfaces either topcoated or untopcoated. Zinc-rich systems are not suitable for certain exposure conditions. (See Section 4 and Table 1.)

2. Description

2.1 GENERAL USAGE:

2.1.1 Zinc-rich coatings are primarily formulated to provide protection to steel by virtue of the galvanic protection provided by the zinc. They also typically provide hard, abrasion-resistant coatings, but flexibility and impact resistance may vary widely. These coatings normally require a blast cleaned surface for best results, and are usually applied in one coat 50 to 125 micrometers (2 to 5 mils) dry film thickness over the cleaned steel.

2.1.2 Some are used as prefabrication primers or shop primers, where they are applied to freshly blast cleaned steel plates and sections. The prefabrication primers, often at a lesser thickness, are intended to protect the steel throughout the fabrication period until the final painting system can be applied to the finished structure. At that juncture, the pre-fabrication primer may be incorporated into the final system or removed. SSPC-PS Guide 22 and SSPC-Paint 30 discuss the use of zinc-rich coatings as prefabrication primers.

2.2 VEHICLES FOR ZINC-RICH COATINGS: Zinc-rich coatings are available as a number of different commercial types. These coatings may be categorized as having inorganic (Type I) or organic (Type II) vehicles.

2.2.1 Inorganic Vehicles: Type I inorganic vehicles include post-cured waterborne alkali silicates (IA); self-cured, waterborne alkali silicates (IB); and self-cured, solvent-borne alkyl silicates (IC). The vehicles of Types IA and IB may include the alkali earth silicates (commonly sodium, lithium, potassium, and ammonium silicate), while IC vehicles are alkyl silicates (most commonly ethyl silicates). Type IA vehicles are post-cured with a separate wash solution, usually mildly acidic in nature, applied as an aftercoat. Type IB vehicles are chemically similar to Type IA vehicles, except they are formulated to self-cure upon exposure to moisture and carbon dioxide in the air. Type IC vehicles self-cure upon exposure to atmospheric moisture.

2.2.2 Organic Vehicles: Type II vehicles include those with thermoplastic binders (IIA) and thermoset binders (IIB). Type II thermoplastic vehicles include polymers of chlorinated rubber, styrene, vinyl, and other organic materials that soften upon exposure to heat. Type IIB thermoset vehicles do not soften upon heating, and include polymers of epoxy, polyurethane, polyester, silicone, and other chemically cross-linked materials.

2.3 PIGMENTATION FOR ZINC-RICH COATINGS: The major pigment component in these coatings is zinc dust of the type described in ASTM D 520. Inorganic zinc-rich coatings contain a minimum zinc dust content of 74 percent by weight in the dry film. Organic zinc-rich coatings contain a minimum zinc dust content of 77 percent by weight in the dry film.

2.4 NUMBER OF COMPONENTS: Inorganic and organic zinc-rich coatings are supplied as a single package or multi-component package. Many multi-component packages have the zinc pigment packaged separately to be mixed with the vehicle at the time of application. All multi-component coatings have a limited pot life after mixing.

3. Reference Standards

3.1 The standards referenced in this guide are listed in Section 3.3 and 3.4.

3.2 The latest issue, revision, or amendment of the reference standards in effect on the date of invitation to bid shall govern unless otherwise specified.

3.3 If there is a conflict between the requirements of any of the cited reference standards and the specification, the requirements of the specification shall prevail.

3.4 SSPC STANDARDS AND JOINT STANDARDS:

Guide 9	Guide for Atmospheric Testing of Coatings in the Field
PA 1	Shop, Field, and Maintenance Painting of Steel
PA 2	Measurement of Dry Coating Thickness with Magnetic Gages
PA Guide 3	A Guide to Safety in Paint Application
SP 5/NACE No. 1	White Metal Blast Cleaning
SP 6/NACE No. 3	Commercial Blast Cleaning
SP 8	Pickling
SP 10/NACE No. 2	Near-White Blast Cleaning
Paint 20	Zinc-Rich Primers (Type I - Inorganic and Type II - Organic)
Paint 29	Zinc Dust Sacrificial Primer, Performance-Based
Paint 30	Weld-Through Inorganic Zinc Primer
PS 12.01	One Coat Zinc-Rich Painting System
PS Guide 8.00	Guide to Topcoating Zinc-Rich Primers
PS Guide 22.00	Guide for Selecting One-Coat Preconstruction or Prefabrication Painting Systems

3.4 AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) STANDARD:

D 520	Specification for Zinc Dust Pigment
D 3925	Practice for Sampling Liquid Paints and Related Pigmented Coatings

4. Selection of Coating System

4.1 CLASSIFYING EXPOSURE ZONES: Successful corrosion protection utilizing a zinc-rich coating system is dependent upon the anticipated service in environmental exposure zones. Guidelines for the use of organic and inorganic zinc-rich coatings, either topcoated or untopcoated, are presented below based on the following SSPC classifications of exposure:

1A	Interior, Normally Dry
1B	Exterior, Normally Dry
2A	Frequently Wet—Fresh Water
2B	Frequently Wet—Salt Water
2C	Fresh Water Immersion
2D	Salt Water Immersion
3A	Atmospheric Chemical Exposures (pH 2 to 5)
3B	Atmospheric Chemical Exposures (pH 5 to 10)
3C	Atmospheric Chemical Exposures (pH 10 to 12)
3D	Chemical Exposure, Solvents
3E	Chemical Exposure, Severe

4.2 GUIDELINES FOR USAGE: The untopcoated and topcoated inorganic and organic zinc-rich coatings are categorized as suitable (recommended), unsuitable (not recommended) or questionable for the exposure environments in Section 4.1. Questionable means that some products may perform satisfactorily, while other products may not, or that the environmental description is too variable to assure satisfactory coating system performance. Guidelines for the use of topcoated and untopcoated zinc-rich primers in various environments are presented below and in Table 1.

4.3 USE OF UNTOPCOATED ZINC-RICH COATINGS:

4.3.1 Untopcoated Inorganic Zinc-Rich Coatings: These coatings may be suitable for use in the following environmental zones: 1A, 1B, 2A, 2B, 3B, and 3D. These coatings are not recommended for the following environmental zones: 3A, 3C, 3E. These coatings are questionable for environmental zones 2C and 2D.

4.3.2 Untopcoated Organic Zinc-Rich Coatings: These coatings may be suitable for use in the following environmental zones: 1A, 1B, 2A, and 3B. These coatings are not recommended for the following environmental zones: 2B, 2D, 3A, 3C, 3D, and 3E. These coatings are questionable for environmental zone 2C.

4.4 USE OF TOPCOATED ZINC-RICH COATING SYSTEMS:

4.4.1 Topcoated Inorganic Zinc-Rich Coating Systems: These systems may be suitable for the following environmental zones: 1A, 1B, 2A, 2B, 3B, and 3C. These systems are not recommended for environmental zone 3E. These systems are questionable for the following environmental zones: 2C, 2D, and 3D.

4.4.2 Topcoated Organic Zinc-Rich Coating Systems: These systems may be suitable for the following environmental zones: 1A, 1B, 2A, 2B, 3B, and 3C. These systems are not recommended for environmental zone 3E. These systems are questionable for the following environmental zones: 2C,2D, 3A, 3D.

4.5 These guidelines are based on the general characteristics of the different types of zinc-rich coating systems and exposure environments. Substantial formulation differences exist among zinc-rich coatings. The ability of a topcoated system to perform adequately is strongly dependent on the generic type and formulation of the topcoat. (See Section 6.3.) Therefore, the recommendations of the coating manufacturer regarding the use of a zinc- rich coating (organic or inorganic, topcoated or untopcoated) in a given environment should be solicited. This is particularly critical when considering use of a zincrich system in a questionable category of Sections 4.3.1, 4.3.2, 4.4.1, 4.4.2 and Table 1.

5. Surface Preparation

5.1 DEGREE OF CLEANING: Although blast cleaning to SSPC-SP 5 may be preferred, it is also the most costly; in most cases a near-white metal blast (SSPC-SP 10) or in some cases even a commercial (SSPC-SP 6) blast may provide a satisfactory surface for these coatings. Table 1 provides minimum surface preparation guidelines for zinc-rich coating systems in various environments. Although this specification is written for blast cleaned surfaces, under certain conditions pickling can be used as a surface preparation for zinc-rich primers if agreed upon by the contracting parties. The pickling procedures shall be in accordance with SSPC-SP 8, "Pickling", paragraph 5.2.1. Specifically, this requires adequate rinsing of all pickling residues with 60°C (140°F) hot water, and prohibits subsequent phosphoric acid or dichromate treatment.

5.2 SURFACE PROFILE: Surface profile should be in the range of 25 to 90 micrometers (1.0 to 3.5 mils) unless otherwise recommended by the coating manufacturer.

6. Coating Materials

6.1 PRIMER: SSPC-Paint 20, Zinc-Rich Primers (Type I-"Inorganic" and Type II-"Organic".)

6.1.1 Zinc-rich coatings are particularly useful for protecting steel surfaces in moist corrosive environments. These primers are very resistant to high humidity and salt air, lasting many years. They galvanically prevent rust undercutting at small breaks in the coating system, often filling the breaks with protective deposits of zinc oxidation products, greatly extending coating life. Unless topcoated, they are unsuitable for acidic or alkaline service outside the pH range from about 5 to 10. Variations in properties of these coatings depends largely on the vehicle, whether inorganic or organic. The choice of best coating for a specific end use must be made by a comparison of properties with the requirements of the service. Application and surface preparation constraints may limit the choice. The degree of corrosion protection desired may be a prime consideration. Zinc-rich coatings are characterized by their abrasion resistance, toughness of film, and galvanic action of the zinc. In wet conditions above 60°C (140°F), zinc-rich primers are not recommended, due to rapid depletion of zinc.

6.1.2 Inorganic: Inorganic zincs, while requiring more care in surface preparation and application compared to organic zincs, have a greater ability to withstand exposure to most solvents, oils, and neutral petroleum products. Some types of inorganic zincs require moisture to cure. Inorganic zincs have a tendency to mudcrack at heavier thicknesses, and dry spray may occur under certain ambient conditions. They function well up to 400°C (750°F) in dry conditions. In wet conditions, zincrich primers function well up to 50°C (120°F). Within the range of 50° to 60°C (120° to 140°F), performance depends upon formulation and the coating manufacturer should be consulted. Compared to organic zincs, inorganic zinc-rich primers generally exhibit more pinholing and bubbling upon topcoating. The minimum zinc loading is 74 percent by weight of zinc in dry film.

6.1.3 Organic: Compared with the inorganic type, the organic zinc primers are generally more tolerant of surface preparation and are easier to topcoat. This type generally does not require moisture to cure, has less tendency to mudcrack, and has less tendency to dry spray. Organic zincs generally provide less resistance to abrasion, solvents, and high temperatures than the inorganics. When left untopcoated, organic zincs may provide less galvanic protection than untopcoated inorganic zincs. This type combines the properties of the organic vehicle with the abrasion resistance and the galvanic action of the zinc pigment. The minimum zinc loading is 77 percent by weight of zinc in dry film.

6.2 ALTERNATE PRIMER: SSPC-Paint 29, "Zinc Dust Sacrificial Primer Performance-Based."

6.2.1 SSPC-Paint 29 is a zinc dust containing primer specification which requires a minimum zinc loading of 50% by weight of dry film rather than the higher loading required by SSPC-Paint 20. SSPC field tests have shown that the practical lower limit for zinc loading is 65 percent.

6.2.2 For Paint 29, the galvanic protection and long-term corrosion resistance are assured by more rigorous performance tests than those required in Paint 20. These include exterior fence tests as well as conventional labora-

tory accelerated testing. Paint 29 establishes three levels of performance. Level 1 is laboratory testing only. Level 2 is a 12 month fence test, and Level 3 is a 30 month fence test. Level 2 may be used as an interim qualification to allow for earlier procurement of the coating.

6.3 TOPCOATS: Suitable topcoating of the zinc-rich primer may provide additional service life. Topcoats must be formulated not only for environmental resistance, but also for suitable application (to minimize pinholing, bubbling, etc.) over a zinc-rich primer. SSPC Guide 8.00, "Guide to Topcoating Zinc-Rich Primers," discusses topcoating of zinc-rich primers.

Table 1 provides guidelines for topcoating zinc-rich primers in various environments.

7. Coating Application

7.1 APPLICATION GUIDELINES: Follow requirements of SSPC-PA 1 for general application guidelines. For application of the zinc-rich, follow requirements of SSPC-PS 12.01; for the topcoat(s) follow SSPC-PS Guide 8.00.

7.2 APPLICATION OF ZINC RICH COATINGS: Zinc-rich coatings vary in application characteristics, depending upon climatic conditions at the time of application. High substrate or ambient temperatures may result in a "dry spray" or porous coating, particularly with inorganic zinc. On windy days, "overspray" may be a problem. Many zinc-rich coatings will not dry or cure properly at extremes of high or low humidity (in excess of 90% or less than 50% relative humidity). All zincrich coatings are preferably applied by spray, but may be brushed for small jobs, or to fill in irregularities. All zinc-rich materials may settle, and care should be taken to ensure they are thoroughly mixed before and during application. Brushing should be done with extreme caution to avoid zinc settlement. Exercise caution during work stoppages to prevent settling of zinc in hoses and equipment.

7.3 FILM THICKNESS: Due to the galvanic action of the zinc, these coatings can give satisfactory performance under mildly corrosive conditions with one coat application as little as 50 micrometers (2 mils) thick. The film thickness should be measured in accordance with SSPC-PA 2.

7.4 APPLICATION OF TOPCOAT: Most of the coatings can be topcoated for improved performance under more severe exposures. Special precautions in cleaning the prime coat prior to topcoating may be required, especially in moderate or severe chemical exposures. When self-coating inorganic zinc-rich coatings, solicit the manufacturer's instructions. Often, organic zinc-rich coatings or non-zinc-rich coatings are used in lieu of self-coating an inorganic zinc-rich primer. (See SSPC-PS Guide 8.00 for additional information.)

8. Submittals

8.1 COATING HISTORY: Documented information with authenticated data detailing the past history and exposure of the coating in terms of service life under specific conditions should be required when preparing specifications for major projects. Details relative to surface preparation and application of coating shall be supplied. SSPC-Guide 9 lists the type of data to be submitted.

8.2 COATING CHARACTERISTICS: Sufficient identifiable characteristics other than trade or brand name or designated number or symbol should be provided to permit laboratory test verification of coating identity. These characteristics should include formulation information readily derivable in a laboratory, including the generic nature of the vehicle, pigment, and volatile portions, the weight per gallon, the percent solids by volume or coverage rate, and other procedures used for quality control during manufacture of the coating.

8.3 TOPCOAT SUBMITTALS: When a tie coat or topcoat is specified, a similar coating history should be required for the entire system as described in Section 8.1. Details relevant to the surface preparation, zinc-rich primer, and subsequent topcoat(s) should be required, along with information regarding the performance or suitability of the system for corrosion protection in the intended environment. (See SSPC-Guide 9.)

8.4 MANUFACTURER'S LITERATURE: This guide is intended to be supplemented by the coating manufacturer's instructions and literature. If the manufacturer's literature or recommendations are to become part of the requirements of a procurement document, they must be submitted as part of the design, or bidding document. The date of the manufacturer's literature and the number of sheets should be listed. In the event of a conflict between the manufacturer's written instructions and this guide, the specifier, or other appropriate authorities, should be notified to provide clarification.

9. Inspection

9.1 All work and materials supplied under this specification is subject to timely inspection by the purchaser or his authorized representative. The contractor shall correct such work or replace such material as is found defective under this specification. (See Note 11.1.) In case of dispute, unless otherwise specified, the arbitration or settlement procedure established in the procurement documents shall be followed. If no arbitration procedure is established, the procedure specified by the American Arbitration Association shall be used.

9.2 Samples of paints under this painting system may

be requested by the purchaser and shall be supplied upon request along with the manufacturer's name and identification for the materials. Samples may be requested at the time the purchase order is placed, or may be taken from unopened containers at the job site.

9.3 Unless otherwise specified, the sampling shall be in accordance with ASTM D 3925.

10. Disclaimer

10.1 While every precaution is taken to ensure that all information furnished in SSPC standards and specifications 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 specification or standard itself.

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

11. Notes

Notes are not a requirement of this specification.

11.1 The procurement documents should establish the responsibility for samples, testing, and any required affidavit certifying full compliance with the specification.

11.2 QUALITY ASSURANCE: The user should ensure that coatings qualified according to SSPC-Paint 20, Zinc-Rich Primers (Type I-"Inorganic" and Type II-"Organic"), or other test methods or procedures will not be different from those actually applied at the jobsite. This assurance can be obtained for vehicle components by obtaining infrared spectrographic curves from the laboratory test sample and comparing them with curves obtained from IR spectra on selected field samples. Pigment components may be similarly compared using atomic absorption or other spectrographic analyses. If there are any significant differences between the spectra obtained from the laboratory and field coating samples, the coating manufacturer should be consulted. Physical tests, such as weight/gallon, viscosity, solids by weight, etc., can also assure quality. If differences occur beyond the coating manufacturer's published tolerance or 15%, the manufacturer should be consulted.

11.3 The degree of deviation from the ideal surface preparation which zinc-rich coatings will tolerate without serious loss of their properties varies considerably from coating to coating. Therefore, adequate instructions from the manufacturer are essential and must be closely followed to ensure maximum performance.

11.4 VOC CONTENT: Each coating, after recommended thinning, must conform to published government regulations regarding volatile organic compound (VOC) content. VOC information should be supplied on the label or the technical data sheet. Various governmental agencies may have different VOC limits or use different methods of testing. The owner may modify this specification as necessary to specify a particular VOC content limit consistent with local regulations. Coatings meeting the composition and performance requirements of this specification usually have a VOC level between 0 and 500 g/L (0 and 4.2 lb/gal).

TABLE 1
Guidelines for Surface Preparation and Topcoating of Zinc-Rich Primers in Various Environments

Note: This table provides general guidelines only. Its use should be limited to determination of generic suitability and minimum surface preparation requirements. There are substantial differences in performance between the various types of zinc-rich coatings in a given environment. These recommendations provide minimum acceptable surface preparation, primer, and topcoating requirements for the designated environmental zones. However, recommendations do not imply equivalent system performance. For specific conditions, the coating manufacturer should be consulted.

ZINC-RICH BINDER TYPES

Environmental Zones		IA		IB		IC		IIA		IIB	
		Untopcoated	Topcoated	Untopcoated	Topcoated	Untopcoated	Topcoated	Untopcoated	Topcoated	Untopcoated	Topcoated
1A	Interior, Normally Dry	R-SP 10	R-SP 10	R-SP 10	R-SP 10	R-SP 6	R-SP 6	R-SP 6	R-SP 6	R-SP 6	R-SP 6
1B	Exterior, Normally Dry	R-SP 10	R-SP 10	R-SP 10	R-SP 10	R-SP 6	R-SP 6	R-SP 6	R-SP 6	R-SP 6	R-SP 6
2A	Frequently Wet, Fresh Water	R-SP 10	R-SP 10	R-SP 10	R-SP 10	R-SP 10	R-SP 10	R-SP 10	R-SP 10	R-SP 10	R-SP 10
2B	Frequently Wet, Salt Water	R-SP 10	R-SP 10	R-SP 10	R-SP 10	R-SP 10	R-SP 10	NR	R-SP 10	NR	R-SP 10
2C	Fresh Water Immersion	Q-SP 5	Q-SP 5	Q-SP 5	Q-SP 5	Q-SP 10	Q-SP 10	NR	Q-SP 10	Q-SP 10	Q-SP 10
2D	Salt Water Immersion	Q-SP 10	Q-SP 10	Q-SP 10	Q-SP 10	Q-SP 10	Q-SP 10	NR	Q-SP 10	NR	Q-SP 10
3A	Chemical Exposure, Acidic (pH 2 to 5)	NR	Q-SP 10	NR	Q-SP 10	NR	Q-SP 10	NR	Q-SP 6	NR	Q-SP 6
3B	Chemical Exposure, Neutral (pH 5 to 10)	R-SP 10	R-SP 10	R-SP 10	R-SP 10	R-SP 6	R-SP 6	R-SP 6	R-SP 6	R-SP 6	R-SP 6
3C	Chemical Exposure, Alkaline (pH 10 to 12)	NR	R-SP 10	NR	R-SP 10	NR	R-SP 6	NR	R-SP 6	NR	R-SP 6
3D	Chemical Exposure, Solvent	R-SP 10	Q-SP 10	R-SP 10	Q-SP 10	R-SP 6	Q-SP 6	NR	NR	NR	Q-SP 6
3E	Chemical Exposure, Severe	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

BINDER TYPES:
IA = Inorganic; post-cured, waterborne alkali silicates
IB = Inorganic; self-cured, waterborne alkali silicates
IC = Inorganic; self-cured, solvent-borne alkyl silicates
IIA = Organic; thermoplastic binders (e.g., phenoxy)
IIB = Organic; thermoset binders (e.g., epoxy polyamide, moisture-cured polyurethane)
RECOMMENDED USAGE:
R = Recommended
NR = Not Recommended
Q = Some products recommended, others not recommended. (See Sections 4.2, 4.3, 4.4, and 4.5.)
RECOMMENDED SURFACE PREPARATION:
The number refers to the minimum SSPC blast cleaning surface preparations as follows:
SP 5 = SSPC-SP 5, White Metal Blast Cleaning
SP 6 = SSPC-SP 6, Commercial Blast Cleaning
SP 10 = SSPC-SP 10, Near-White Blast Cleaning
NOTE: For pitted old steel, the blast cleaning requirement should be the next higher degree of cleanliness, i.e., the SP 10 shown above should be SP 5, the SP 6 shown above should be SP 10.