SSPC: The Society for Protective Coatings

Using SSPC Coating Material Standards

Coating Selection

SSPC coating material standards contain requirements for the performance of various types of coatings when tested in accordance with industry-established laboratory and field standards. The tests used to establish coating performance vary depending upon the type and intended use of the coating, and are selected by industry consensus to be appropriate for evaluating performance of all well-prepared coatings of a specific type. Specifiers who plan to use SSPC coating standards in their project specifications must make informed choices when selecting the proper coating system for a specific project. Most protective coatings are designed to work in systems of several compatible coatings: a primer, an intermediate coat and a topcoat, Manufacturers usually design individual coatings to allow for some mix-and-match among these components to obtain a system that has the desired performance properties for a specific service environment. Therefore, one of the first steps in coating selection is evaluating the coating's service environment to analyze the stresses that it will impose upon the various components of a coating system, and thus determine the properties required for optimum coating performance. Compatibility of different coatings in a selected system can be determined by standard compatibility testing.

Environmental Zones

SSPC has developed descriptions of "environmental zones " to characterize the type of environment to which the coated steel or concrete will be exposed when in service. For purposes of classifying environmental exposures according to their severity, they have been divided into environmental zones from essentially non-corrosive dry interiors (Zone 0) to severe chemical or temperature exposures (Zones 3 and 4). Zones 3A, 3B, and 3C are for exposures to vapors from different concentrations of mineral acids such as hydrochloric acid and nitric acid that emit acidic vapors. Zone 3E includes combinations of aggressive chemical and atmospheric exposure. In Zone 3E, oxidizers that may be in the atmosphere include ozone, hydrogen peroxide and other inorganic peroxides, nitrous oxide, and halogens. In Zone 4A, inorganic coatings, such as thermal spray metals or coatings with silicon-containing polymer rather organic polymer binders must be used to withstand deterioration from extremely high elevated temperatures.

TABLE 1
SSPC ENVIRONMENTAL ZONES

Zone No.	Characteristics of Service Environment
0	Dry interiors where structural steel is embedded in concrete, encased in masonry, or protected by membrane or non-corrosive contact type fireproofing.
1A	Interior, normally dry (or temporary protection). Very mild.
1B	Exterior, normally dry. Coatings may be subject to exposure to sunlight.
2A	Frequently wet by fresh water. Coating may be subject to condensation, splash, spray or frequent immersion.
2B	Frequently wet by salt water. Coating may be subject to condensation, splash, spray, or frequent immersion.
2C	Fresh water immersion. Coating is constantly submerged.
2D	Salt water immersion. Coating is constantly submerged.
3A	Chemical atmospheric exposure, acidic (pH 2.0 to 5.0)
3B	Chemical atmospheric exposure, neutral (pH 5.0 to 10.0)
3C	Chemical atmospheric exposure, alkaline (pH 10.0 to 12.0)
3D	Chemical atmospheric exposure, presence of mild solvent fumes. Intermittent contact with aliphatic hydrocarbon solvents (e.g., mineral spirits), lower alcohols, glycols, etc.
3E	Chemical atmospheric exposure, severe. Includes oxidizing chemicals, fumes from strong solvents, extreme pHs, or combinations of these with high temperatures.
4A	Extremely high temperatures, e.g., 650° F (330° C) and higher

This classification of environmental exposures is one of the most useful designations, since most available data on coating exposures is defined in these broad terms. Factors such as time-of-wetness, chloride level, sulfur dioxide content, pH, conductivity, surface contamination, etc., should also be considered when choosing a coating system. Exposure conditions may be such as to require little or no protection by coating; conversely, they may indicate the need for elaborate surface preparation, pretreatment, and properly selected primer, intermediate, and finish coats, or supplemental cathodic protection.

A single building or structure may require selection of coatings for service in several different environmental zones. For example the coatings used in a single steel-framed building, part of which is devoted to office space, and other parts of which are devoted to chemical laboratory, and to pilot plant testing where acidic fumes are frequently generated, would be exposed in significantly different environmental zones.

Another example of multiple environments is the different components of a highway bridge located in a geographical area where cyclic freezing/thawing and road salt use are common. The upper portions of such a bridge must be protected only against weather exposure, but the roadway steel and adjacent structural components must also be protected from corrosion by de-icing salt in solution, and the submerged supports must resist deterioration associated with water immersion and freezing thawing conditions.

Other Factors Affecting Selection of Painting Systems.

In general, painting materials and services are selected for procurement documents based upon (1) the severity of the prevailing forces of deterioration of the substrate and (2) the capability of the selected coating system to protect the substrates from these forces for a desired period of time at minimal cost. Additional practical concerns that specifiers must use in selection of coating systems include the condition of the substrate to be coated, the intended service life of the structure to be coated, the desired life of the coating system, access to the work, and economic considerations.

For procurement documents for the repair of existing coating systems, it is wise to use portions of the original coatings which have been saved for this purpose or to procure additional amounts of the original coatings. This will ensure compatibility of the repair system with the existing coating system.

Perhaps the most practical method of determining a suitable coating system for a particular project is by reviewing past histories of coating systems used in similar projects. Fortunately, twelve industries have developed eight charts showing the effectiveness of commonly used coating systems for selected industrial operations. It should be noted that these charts represent a cross-section of industries and coating systems and are not intended to be exhaustive. The eight charts are presented as Tables 2 through 9. They were taken from SSPC's book *Selecting Coatings for Industrial and Marine Structures*. This book provides much more detailed technical information on specific generic coatings and their uses.

TABLE 2
COATING SYSTEM FOR HIGHWAY BRIDGES (NEW AND MAINTENANCE)
(SSPC Environmental Zones 2A, 2B, possibly also 3A, 3B, 3C, 3D depending on bridge location)

Coating System	Highway Bridges (New)	Highway Bridges (Maintenance 1)	Highway Bridges (Maintenance 2)
Inorganic Zinc-Rich Primer/Polyamide Epoxy/Acrylic Polyurethane	√		
Organic Zinc-Rich Primer/Polyamide Epoxy/Acrylic Polyurethane	√	√	
Organic Zinc-Rich Primer/ Polyamide Epoxy/Polysiloxane	√		
Organic Zinc-Rich Primer/ Polyamide Epoxy/Fluoropolymer	√	√	
Organic Zinc-Rich Primer/Polyurea	√	√	
Moisture Cure Urethane Zinc-Rich Primer/Moisture Cure Urethane/ Moisture Cure Urethane	√	√	
Moisture Cure Urethane Zinc-Rich Primer/Moisture Cure Urethane/Acrylic Polyurethane	√	√	
Inorganic Zinc-Rich Primer/Water- borne Acrylic	√		
Polyurea/Polyurethane Hybrid	√	√	
Organic Zinc-Rich Primer/ Water- borne Acrylic		√	
Thermal Spray Coating/Sealer	√	√	
Epoxy Sealer/Epoxy Mastic/Acrylic Polyurethane			√
Epoxy Mastic/ Acrylic Polyurethane			√
Epoxy Mastic/ Waterborne Acrylic			√
Moisture Cure Urethane Sealer/Moisture Cure Urethane/ Moisture Cure Urethane			√
Moisture Cure Urethane/Moisture Cure Urethane/Acrylic Polyurethane			√
Alkyd/Silicone Alkyd			√
Calcium Sulfonate Alkyd (2 coats)			√

Maintenance 1: Total removal and replacement of existing system
Maintenance 2: Spot repair and overcoat

TABLE 3
COATING SYSTEMS FOR WATER STORAGE (INTERIOR/EXTERIOR} TANK LININGS)
SSPC Environmental Zones 2A, 2 C, possibly also 3A, 3B, 3C, 3D,
3E, depending on location of tank for exterior systems

Coating System	Water Storage (interior)[1]	Water Storage (exterior)	Tank/Vessel Linings[2]
Organic Zinc-Rich Primer/Polymide Epoxy/Polysiloxane		√	
Moisture-Cure Urethane Zinc-rich Primer/Moisture-Cure Urethane/ Moisture-Cure Urethane		√	
Organic Zinc-Rich Primer/Waterborne Acrylic		√	
Thermal Spray Coating			√
Moisture-Cure Urethane/Moisture-Cure Urethane/Acrylic Polyurethane		√	
Alkyd/Silicone Alkyd		√	
Polyamide Epoxy (2-3 cts)	√		
Organic Zinc-Rich Primer/Polyamide Epoxy/Polyamide Epoxy	√		
Polyurea/Polyurethane Hybrid	√		
Baked Phenolic			√
Baked Phenolic/Polyamide Epoxy			√
Polyester			√
Vinyl Ester			√
Inorganic Zinc-Rich Primer			√

[1] NSF 61 approval required for potable water storage.
[2] Railcar, food processing, chemical, etc.

TABLE 4
COATING SYSTEMS FOR WASTE WASTER FACILITIES
SSPC Environmental Zones 2A, 2C, 3A

Coating System	Submerged	Severe Damp Atmospheric	Mild Exterior	Mild Interior	Elevated Temperature
Epoxy Mastic/Acrylic Polyurethane			√		
Alkyd (3 cts.)				√	
Alkyd/Silicone Alkyd			√		
Polyamide Epoxy (2-3 cts.)	√			√	
Organic Zinc-Rich Primer/ Polyamide Epoxy/Polyamide Epoxy		√			
Coal Tar Epoxy	√				
Waterborne Acrylic (3 coats)			√	√	
Moisture Cure Urethane (3 coats)			√		
Polyurea/Polyurethane Hybrid	√	√	√	√	
Inorganic Zinc-Rich Primer/Silicone					√

TABLE 5
COATING SYSTEMS FOR POWER GENERATING FACILITIES (COAL-FIRED PLANTS)
SSPC Environmental Zones 2A, 3A, 3C, 3E, 4A

Coating System	Coal Handling	Structural Steel	Hydraulic Structures	High Temperature Surfaces	Mechanical Equipment	Flue Gas Desulfurization (exterior)	Flue Gas Desulfurization (interior)	Water Treatment (exterior)	Water Storage (interior)
Inorganic Zinc-Rich Primer/ Polyamide Epoxy/Acrylic Polyurethane		√						√	
Inorganic Zinc-Rich Primer/ Polyamide Epoxy						√		√	
Organic Zinc-Rich Primer/ Polyamide Epoxy/Acrylic Polyurethane		√							
Inorganic Zinc-Rich Primer/ Waterborne Acrylic		√							
Organic Zinc-Rich Primer/ Waterborne Acrylic		√							
Alkyd (3 cts.)					√				
Alkyd (2 cts.)/Silicone Alkyd		√							
Polyamide Epoxy (2-3 cts.)	√	√				√			√
Organic Zinc-Rich Primer/ Polyamide Epoxy/ Polyamide Epoxy	√	√							√
Polyurea/Polyurethane Hybrid								√	√
Polyester			√						
Vinyl Ester							√		
Inorganic Zinc-Rich Primer				√					
Coal Tar Epoxy			√						
Inorganic Zinc-Rich Primer/ Silicone				√					
Phenolic Epoxy			√						
Silicone				√					

TABLE 6
COATING SYSTEMS FOR POWER GENERATING FACILITIES (NUCLEAR POWER)

Coating System	Supression Chamber	Structural Steel (inside containment)	Concrete Wall/Floors	Structural Steel (outside containment)	Hydraulic Structures	Mechanical Equipment	Water Treatment (exterior)	Water Storage (interior)
Inorganic Zinc-Rich Pimer/ Polyamide Epoxy/Acrylic Polyurethane				√			√	
Inorganic Zinc-Rich Primer/ Polyamide Epoxy		√					√	
Organic Zinc-Rich Primer/ Polyamide Epoxy/Acrylic Polyurethane			√					
Inorganic Zinc-Rich Primer/ Waterborne Acrylic				√				
Organic Zinc-Rich Primer/ Waterborne Acrylic				√				
Alkyd (3 cts.)						√		
Alkyd (2 cts.)/Silicone Alkyd				√				
Polyamide Epoxy (2-3 cts.)	√	√		√				√
Organic Zinc-Rich Primer/ Polyamide Epoxy/ Polyamide Epoxy				√				√
Polyester					√			
Inorganic Zinc-Rich Primer	√	√						
Coal Tar Epoxy					√			
Phenolic Epoxy	√	√			√			
Thermal Spray Coating/ Polyamide Epoxy	√							
Thermal Spray Coating/ Phenolic Epoxy	√							
Epoxy Surfacer/Polyamide Epoxy			√					

TABLE 7
COATING SYSTEMS USED IN PULP AND PAPER FACILITIES, LOCK AND DAM STRUCTURES, CHEMICAL PLANTS, AND BURIED PIPELINES
SSPC Environmental Zones 2A, 2C, 3A, 3B, 3C, 3E, 4A (depending on type of service)

Coating System	Pulp & Paper (pH<5)	Pulp & Paper (pH>4)	Lock & Dam Structures	Buried Pipeline	Chemical Plants (see Note 1)
Epoxy Mastic/Amine Adduct Epoxy/ Polyester Polyurethane	√				
Epoxy Mastic/Polyamide Epoxy/Acrylic Polyurethane		√			
Zinc-Rich Primer/Moisture Cure Urethane/Moisture Cure Urethane			√		
Polyurea/Polyurethane Hybrid	√	√	√		
Thermal Spray Coating/Sealer			√		
Polyamide Epoxy (2-3 cts.)			√		
Coal Tar Epoxy			√		
Polyamide Epoxy/Acrylic Polyurethane			√		
Organic Zinc-Rich Primer/Vinyl (see Note 2)			√		
Coal Tar				√	
Fusion Bonded Epoxy				√	
Polyethylene				√	
Polypropylene				√	
Tapes				√	
Heat-Shrink Sleeves				√	

Note 1: Service environments highly variable (e.g. mineral acids, organic acids, caustics, corrosive salts, solvents, gases, weather extremes). No panacea coating system. Common generic coating types include zinc-rich primers, epoxies, polyureas, polyurethanes, and aluminum filled silicones (for high temperature resistance).

Note 2: Because of their high VOC contents, vinyl systems are used on navigation dams and other structures where the level of abrasion is high and frequent maintenance is impractical.

TABLE 8
COATING SYSTEMS FOR SHIPS AND MARINE STRUCTURES
SSPC Environmental Zones 2A, 2B, 2C, 2D

Coating System	Ballast Tanks	Interior Accommodations	Engine Room Decks	Engine Room Bulkheads	Engine Room High Temperature	Engine Room Steel Piping	Topside	Underwater Hull	Platforms
Inorganic Zinc-Rich Pimer/ Polyamide Epoxy/Acrylic Polyurethane							√		√
Alkyd (3 cts.)		√		√			√		
Polyamide Epoxy (2-3 cts.)	√		√	√		√	√		√
Coal Tar Epoxy	√								
Waterborne Acrylic (3 cts.)		√							
Inorganic Zinc-Rich Primer/High Temperature Silicone					√				√
Phenolic Epoxy						√			
Epoxy Mastic	√	√	√	√			√		
100% Solids Epoxy	√								
Fire Resistant Coatings		√							√
Anti-Corrosive (epoxy)/Antifouling								√	
Alkyd (2 cts.)/Silicone Alkyd							√		
Polyurea/Polyurethane Hybrid									√

TABLE 9
COATING SYSTEMS FOR FOOD MANUFACTURING FACILITIES
SSPC Environmental Zones 2A, 2C, 3A, 3B, 3C, 4A

Coating System	Ceilings, Sutructural Steel, and Handrails	Equipment	Equipment Motors	Steel Tank Linings	Exposed Exterior Metal Surfaces	Freezer Areas	Refrigerated Boxcars and Tank Car Exteriors	Coatings for Boilers and Various Piping	Highly Acidic Conditions
Conventional Epoxies	√	√							
Epoxy-Polyester			√						
High Solid Epoxies				√					
Phenolic Epoxies				√					
Novolac Epoxies				√					
Urethane					√		√		
Alkyd	√	√			√				
Polyurea						√	√		
Acrylic	√	√			√				
Zinc-Rich Coatings	√	√	√	√					
Silicone								√	
Vinyl Ester									√

Surface Preparation Considerations

Even the best coating system will not perform satisfactorily if the substrate has not been cleaned and profiled to the levels necessary for long-term coating adhesion. The product data sheets of most coating manufacturers contain recommendations for the type and level of surface preparation to ensure optimum coating performance.

The method of surface preparation as well as the surface cleanliness required must be considered when selecting coatings for a project, particularly when coating maintenance is being performed. If the surface cannot be prepared as required for a certain coating due to project-specific logistical or environmental conditions, another coating selection should be considered.

General information about methods and types of surface preparation for industrial coatings used on steel and concrete surfaces can be found in the SSPC "Surface Preparation Commentary" (SSPC-SP COM).

Application Considerations

Proper mixing and application of coatings and coating systems is critical to obtaining optimum performance. Information specific to the mixing and application of a coating is provided on the coating's product data sheet. The configuration of and access to the area being coated may restrict the application methods that can be used. Application by methods other than those recommended by the manufacturer will result in poor performance.

SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," contains requirements for best practices for mixing and applying industrial protective coatings, as well as general information about commonly encountered application methods. If information in SSPC-PA 1 differs from the specific recommendations in the coating manufacturer's product data sheets, the contractor or specifier should seek clarification from the coating manufacturer's technical representative. The product data sheets, developed for a specific coating product, will usually will usually take precedence over requirements of SSPC-PA 1.

Guidance for best practice in application of coatings to concrete surfaces is presented in SSPC-PA 7, “Applying Thin-Film Coatings to Concrete,” SSPC-Guide 20, Procedures for Applying Thick Film Coatings and Surfacings Over Concrete Floors” and SSPC-TU 2/NACE 6G197, “Design, Installation, and Maintenance of Coating Systems for Concrete Used in Secondary Containment,” as well as SSPC’s book *The Fundamentals of Cleaning and Coating Concrete.*

Selecting the proper coating for a specific project involve consideration of many variables. The most obvious is the service environment of the coating, but constraints imposed on surface preparation and application procedures can also influence the specifier’s choice of coating. The specifier may need to research the requirements for several options, and consult coating product data sheets and manufacturer’s technical representatives. It is also advisable to have as much knowledge of the specific project requirements and site conditions as possible, which may require a visit to the project site itself prior to making a final coating system selection.

Additional Sources of Information

SSPC has many resources available to assist specifiers, facility owners, and contractors who would like to expand their understanding of various aspects of selection and application of protective coatings for steel and concrete in industrial and commercial service. Information on training programs is available at http://www.sspc.org/training/training-home/. The SSPC training courses “Developing an Effective Coating Specification,” “Fundamentals of Protective Coatings,” and “Planning and Specifying Industrial Maintenance Coatings Projects” may be of particular interest to specifiers. To obtain information on SSPC printed books, visit <http://www.sspc.org/market-place/books/>. Of particular interest is the book *Selecting Coatings for Industrial and Marine Structures*. SSPC members may download SSPC standards via http://www.sspc.org/members-area/ (this link requires your membership number for access). Non-members may purchase standards (and individual memberships) via the SSPC Marketplace http://www.sspc.org/market-place/. Electronic copies of the Technical Insight reports on “Preparing and Using Protective Coating Specifications,” and the “Specification Checklist for Steel and Concrete Coating” are available from http://www.sspc.org/market-place/technical-insight-reports/.