SSPC: The Society for Protective Coatings

TECHNOLOGY GUIDE 25

Guide for Use and Selection of Powder Coating Systems for Protective Purposes

1. Scope

1.1 This guide provides general information to assist facility owners and specifiers who select or specify powder coating systems to protect steel substrates from corrosion. It includes information about surface preparation and application procedures, and also about coating system durability and performance. Detailed descriptions of substrate selection and pretreatment are beyond the scope of this guide. Coating powder suppliers can provide advice regarding selection of specific primers and finish coats, and powder application and recovery equipment suppliers can assist with the selection of specific equipment.

1.2 The powder coatings discussed in this guide are suitable for use in the following SSPC Environmental Zones described in Section 1 of *SSPC Painting Manual Volume 2, Systems and Specifications* and ISO 12944-2:

Note: The ISO Corrosivity Categories do not directly correspond to the SSPC Environmental Zones. Table 1 shows an approximate comparison.

1.3 TYPICAL APPLICATIONS FOR INDUSTRIAL POWDER COATINGS: Handrail, fences, structural façade components, chemical tank linings, pipeline coatings, decorative façade components, structural steel components. Original equipment manufacturing (OEM) applications also include powder coatings but are not within the scope of this guide.

1.4 UNITS OF MEASURE: This standard provides both IEEE/ASTM/SI 10,[1] International Standards (SI) units and U.S. Customary units. The measurements are not exact equivalents; therefore, each system must be used independently of the other without combining in any way.

[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.

TABLE 1
SSPC ENVIRONMENTAL ZONES AND ISO CORROSIVITY CATEGORIES

SSPC Zone	Environment description	ISO 12944-2 Atmospheric Corrosivity Category
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.	C1
1B	Exterior, normally dry. Coatings may be subject to exposure to sunlight.	C2
2A	Frequently wet by fresh water. Coating may be subject to condensation, splash, spray or frequent immersion.	C3/Im 1
2B	Frequently wet by salt water. Coating may be subject to condensation, splash, spray, or frequent immersion.	C5-M/Im 2
3A	Chemical atmospheric exposure, acidic (pH 2.0 to 5.0)	C5-I
3B	Chemical atmospheric exposure, neutral (pH 5.0 to 10.0)	C5-I
3C	Chemical atmospheric exposure, alkaline (pH 10.0 to 12.0)	C5-I
3D	Chemical atmospheric exposure, presence of mild solvent fumes. Intermittent contact with aliphatic hydrocarbon solvents (e.g., mineral spirits) , lower alcohols, glycols, etc.	C5-I
3E	Chemical atmospheric exposure, severe. Includes oxidizing chemicals, fumes from strong solvents, extreme pH's, or combinations of these with high temperatures.	C5-I

This standard, developed by the SSPC 1.7 Powder Coatings Committee, was approved in April 2019.

This standard uses U.S. Customary units with approximate SI units shown in parentheses.

2. Referenced Standards

2.1 SSPC STANDARDS AND JOINT STANDARDS

The user should always consult the latest revision of the standards listed below:

SSPC-CS 23.00/AWS C.2.23/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-PA 2	Procedure for Determining Conformance to Dry Film Thickness Requirements
SSPC-PA Guide 11	Guide to Methods for Protection of Edges, Crevices, and Irregular Steel Surfaces
SSPC-PA 17	Procedure for Determining Conformance to Steel Profile/Surface Roughness/Peak Count Requirements
SSPC-SP 10/ NACE No. 2	Near-White Blast Cleaning
SSPC-SP 16	Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals
SSPC-Guide 15	Field Methods for the Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Surfaces
SSPC-VIS 1	Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

2.2 ASTM STANDARDS

ASTM D522/ D522M	Standard Methods for Mandrel Bend Test of Attached Organic Coatings
ASTM D523	Standard Test Method for Specular Gloss
ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D2794	Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D3359	Standard Test Methods for Measuring Adhesion by Tape Test
ASTM D3363	Standard Test Method for Film Hardness by Pencil Test
ASTM D4417	Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D5162	Standard Practice for Steel Discontinuity (Holiday) Testing for of Nonconductive Protective Coatings on Metallic Substrates
ASTM D5402	Standard Practice for Assessing the Solvent Resistance of Organic Coatings Using Solvent Rubs
ASTM D6677	Standard Test Method for Evaluating Adhesion by Knife
ASTM D7091	Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals
ASTM D7378	Standard Practice for Measurement of Thickness of Applied Coating Powders to Predict Cured Thickness.

2.3 AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA) STANDARDS[2]

AAMA 2603	Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix)
AAMA 2604	Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix)
AAMA 2605	Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix)

2.4 INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO) STANDARDS[3]

ISO 12944-2	Paints and varnishes–Corrosion protection of steel structures by protective paint systems–Part 2: Classification of environments

[2] American Architectural Manufacturers Association, 1827 Walden Office Squire Suite 550, Schaumberg, IL 60163. Phone 847-303-5664. Standards available at <http://www.aamanet.org>

[3] International Organization for Standardization (ISO), Case Postale 56, Geneva H-1211, Switzerland. In the United States, ISO standards may be obtained from the American National Standards Institute (ANSI) at <http://www.ansi.org>

ISO 8501-3	Preparation of steel substrates before application of paints and related products–Visual assessment of surface cleanliness–Part 3: Preparation grades of welds, edges and other areas with surface imperfections

2.5 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) STANDARD[4]

NFPA 33	Standard for Spray Application using Flammable or Combustible Materials

2.6 POWDER COATINGS INSTITUTE[5]

- Powder Coatings, The Complete Finisher's Handbook
- Guidelines for Powder Coating Various Metal Substrates
- Recommended Procedures for Powder Coatings

3. Glossary of Terms Associated with the Use of Powder Coatings

Many of the specialized terms used in the powder coatings industry are defined below.

Back ionization: The excessive build-up of charged powder particles on item being coated that causes a visible "starburst" or "starring" effect on the surface.

Coating powders: Finely divided particles of resin, either thermoplastic or thermoset, generally incorporating pigments, fillers, and additives and remaining finely divided during storage under suitable conditions, which, after fusing and possibly curing, give a continuous film.[6]

Corona charging of particles: System for imparting electrostatic charge to powder passing through an electric field generated by a high-voltage device.

Electrostatic spray: Method of typical application of powder coating products using either manual or automated spray guns that apply a positive electrical charge to the powder particles as they pass the gun tip electrode and become airborne. These particles then adhere to grounded metal products with a high percentage of coating product transfer efficiency.

Faraday cage effect: The inability of electrostatic spray to be properly applied to an area of an item because of Faraday Cage effects caused by its geometric configuration, most notably in recessed corners of the work piece.

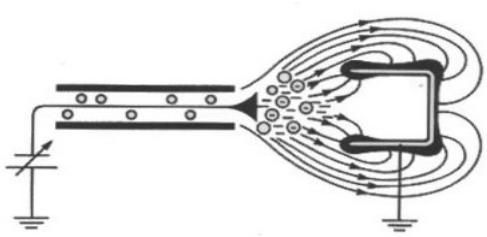

Figure 1. Faraday Cage Effect.

FEVE: Fluoroethylene-vinyl ether

PVDF: Polyvinylidene difluoride

Fluidized bed: Powder coating application method in which a heated or electrostatically charged item is immersed in or passed over a fluidized bed of coating powder that adheres to the metal. The item is then heated in an oven to fuse the coating to the metal.

Fluidizing: Suspending finely divided powder particles in air, usually by passing air through the porous bottom of the vessel containing the powder.

Fusion: Melting, flowing, and coalescence of solid particulates such as powders by heating.

Orange peel: An irregular surface condition resembling the skin of an orange in areas where the coating was unable to level itself due to a constant thickness. This condition can also be caused by excess free ions or poor particle size distribution within the powder.

Outgassing (of powder coating): Air or gas that escapes from a substrate beneath a coating or from a chemical reaction of the coating and causes formation of blisters, bubbles, or small holes in the coating.

Overbaking: Exceeding the recommended curing conditions of a powder coating by subjecting the applied coating to excessive temperature and/or time at a temperature. This condition can cause discoloration, variation in gloss, and possible degradation of mechanical properties.

Overspray of powder: Sprayed coating powder that misses its target during the application process.

Particle size: Average diameter of powder particles.

Recovery: The process by which oversprayed powder particles are collected.

Reclamation: The process by which recovered powder particles are collected, recycled, and mixed with virgin powder for reuse.

[4] National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471 Telephone: +1 617 770-3000 Fax: +1 • 770-0700.

[5] The Powder Coating Institute, 5040 Old Taylor Mill Road, PMB 13, Taylor Mill KY 41015. Phone 859-929-9988, <http://powdercoating.org>

[6] ASTM D7378 (latest revision), Standard Practice for Measurement of Thickness of Applied Coating Powders to Predict Cured Thickness.

Spray booths: Specially designed containment enclosures for powder coating application that permit the recovery of oversprayed powders.

TGIC polyester: A polyester coating powder cured with triglycidyl isocyanurate.

Thermoplastic powders: Polymeric powders that are not changed chemically by fusion and retain their original properties after solidification.

Thermoset powders: Polymeric powders that chemically react during heat curing, resulting in a high molecular weight matrix with increased chemical and physical properties.

Transfer efficiency: The ratio of the coating powder deposited compared to the amount directed at the work piece to be coated.

Tribo charging: Creating a static charge on powder particles by friction as the powder passes through the gun.

Sintering: The process of compacting a powder to form a solid mass of material without melting it to the point of liquefaction.

Virgin powder: Powder that has not been previously used, as compared to reclaimed powder.

Electrostatic Wrap: The ability of an electrostatically applied sprayed coating (liquid or powder) to seek and bond to areas of the item to be coated that are not in a direct line-of-sight with the gun.

4. Advantages of Powder Coatings

4.1 HIGH TRANSFER EFFICIENCY: When applied and cured properly onto appropriately prepared surfaces, suitably selected and qualified powder coatings have very high transfer efficiencies. Recycling of untransfered coating and overspray materials is possible in some operations that use electrostatic or fluidized bed application. Coating overspray is reclaimed and blended with virgin powder for reuse.

4.2 HIGH FILM BUILD: The desired film thickness can usually be obtained in a single layer, but two- or three-layer systems are often used, improving edge protection performance.

4.3 NO PRODUCT VOCS, THINNERS OR REDUCERS: Most coating powder residue may be classified as non-hazardous waste. It is recommended that coating powder be sintered prior to disposal. Check local regulations, as they change frequently.

4.4 ADHESION AND IMPACT RESISTANT: Powder products are baked and melted onto substrates creating a strong bond and are typically very hard and durable. This can reduce the possibility of shipping and handling damage provided the coated components are properly packaged.

5. Limitations of Powder Coatings

5.1 The powder coating should be selected to be compatible with the substrate. The substrate should withstand the heat of the curing oven.

5.2 Powder coatings are not typically field-applied unless flame spray thermoplastics are used. When applying thermoset coating powders, the size of components being coated is limited by the size of the curing oven

5.3 Atomized powder in air can be ignitable at proper concentrations. See additional information in NFPA 33.

5.4 Due to the high electrical charges used in many applications, special safety precautions must be followed. Grounding of conductive objects in the spray area is the most important safety precaution. See additional information in NFPA 33.

5.5 Electrostatic spraying conditions can restrict the deposition of the powder into interior recessed areas and corners (Faraday cage effect). This effect can be controlled using automatic current control, free-ion collection devices, adjusting voltage (KV) along with adjusting the distance from the gun to the work piece. Advanced gun designs may allow more control of application and reduced effects of Faraday Cage (see Figure 2).

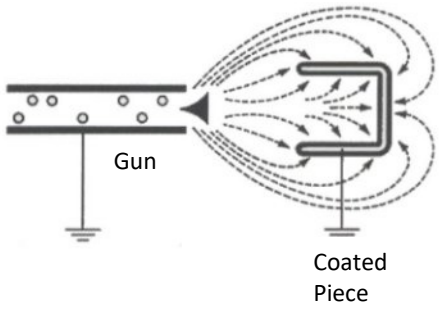

Figure 2. Minimized Faraday Cage Effect.

5.6 Overbaking at overly high temperatures during curing can damage coating film and affect performance. Undercuring due to inadequate oven circulation can also adversely affect performance of the coatings.

6. Manufacture and Storage of Coating Powders

6.1 Close quality control is required during manufacture of coating powders, because once manufactured, powders