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## Standard Guide for Painting Inspectors (Metal Substrates)<sup>1</sup>

This standard is issued under the fixed designation D3276; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

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<sup>ε1</sup> NOTE—Editorial corrections were made in Section 2 and 5.3.5.1 in November 2016.

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### 1. Scope

1.1 This guide is intended as an information aid to painting inspectors in carrying out their task efficiently. It includes the key elements of surface preparation, coatings application, and final approval for both field and shop work. The items should be selected that are pertinent to the specification of a particular job.

NOTE 1—For additional helpful information, refer to the following documents:

*Manual of Coating Work for Light-Water Nuclear Power Plant Primary Containment and Other Safety-Related Facilities*<sup>2</sup>

*New Concepts for Coating Protection of Steel Structures*<sup>3</sup>

**D16** Terminology for Paint, Related Coatings, Materials, and Applications<sup>4</sup>

**D4538** Terminology Relating to Protective Coatings and Lining Work for Power Generation Facilities<sup>4</sup>

Steel Structures Painting Manual Vol 1 Good Painting Practice<sup>5</sup>

Steel Structures Painting Manual Vol 2 Systems and Specifications<sup>5</sup>

Manufacturers Specifications and Instructions (made available to the inspector for reference to special requirements for proper application)

Safety Data Sheets (needed to ensure that personnel take necessary precautions in handling hazardous materials). Available from Materials manufacturer.

1.2 Certain industries or owners may require certified inspection personnel. See Guide **D4537** for establishing procedures to certify inspectors for coatings work in nuclear facilities.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

~~1.4 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.~~

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee **D01** on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee **D01.46** on Industrial Protective Coatings.

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<sup>2</sup> ASTM, 1979.

<sup>3</sup> *ASTM STP 841*, ASTM, 1984.

<sup>4</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>5</sup> Available from Society for Protective Coatings (SSPC), 40 24th St., 6th Floor, Pittsburgh, PA 15222, <http://www.sspc.org>; Association for Materials Protection and Performance (AMPP), 15835 Park Ten Place, Houston, TX 77084, <https://www.ampp.org>.

1.4 This guide is arranged in the following order:

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1.5 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

1.6 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>4</sup>

- D16 Terminology for Paint, Related Coatings, Materials, and Applications
  - D1212 Test Methods for Measurement of Wet Film Thickness of Organic Coatings
  - D1730 Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting
  - D2200 Practice for Use of Pictorial Surface Preparation Standards and Guides for Painting Steel Surfaces
  - D3359 Test Methods for Rating Adhesion by Tape Test
  - D3363 Test Method for Film Hardness by Pencil Test
  - D4138 Practices for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive, Cross-Sectioning Means
  - D4212 Test Method for Viscosity by Dip-Type Viscosity Cups
  - D4285 Test Method for Indicating Oil or Water in Compressed Air
  - D4414 Practice for Measurement of Wet Film Thickness by Notch Gages
  - D4417 Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
  - D4537 Guide for Establishing Procedures to Qualify and Certify Personnel Performing Coating and Lining Work Inspection in Nuclear Facilities
  - D4538 Terminology Relating to Protective Coating and Lining Work for Power Generation Facilities
  - D4541 Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
  - D4752 Practice for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub
  - D4940 Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blast Cleaning Abrasives
  - D5064 Practice for Conducting a Patch Test to Assess Coating Compatibility
  - D5162 Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates
  - D5402 Practice for Assessing the Solvent Resistance of Organic Coatings Using Solvent Rubs
  - D6386 Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
  - D6677 Test Method for Evaluating Adhesion by Knife
  - D6913 Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
  - D7091 Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals
  - D7127 Test Method for Measurement of Surface Roughness of Abrasive Blast Cleaned Metal Surfaces Using a Portable Stylus Instrument (Withdrawn 2021)<sup>6</sup>
  - D7393 Practice for Indicating Oil in Abrasives
  - E337 Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures)
- 2.2 ~~Occupational Safety and Health Administration (OSHA) OSHA Standard:~~<sup>5</sup>
- 29 CFR 1926.59 Hazard Communication
- 2.3 ~~SSPC: The Society for Protective Coatings (SSPC) SSPC Standards:~~<sup>5</sup>
- SSPC-AB 1 Mineral and Slag Abrasives
  - SSPC-AB 2 Cleanliness of Recycled Ferrous Metallic Abrasives

<sup>6</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

SSPC-AB 3 Newly Manufactured or Re-Manufactured Steel Abrasives  
 SSPC-AB 4 Recyclable Encapsulated Abrasive Media  
 SSPC-SP 1 Solvent Cleaning  
 SSPC-SP 2 Hand Tool Cleaning  
 SSPC-SP 3 Power Tool Cleaning  
 SSPC-SP 5/NACE No. 1 White Metal Blast Cleaning  
 SSPC-SP 6/NACE No. 3 Commercial Blast Cleaning  
 SSPC-SP 7/NACE No. 4 Brush-off Blast Cleaning  
 SSPC-SP 8 Pickling  
 SSPC-SP 10/NACE No. 2 Near-White Blast Cleaning  
 SSPC-SP 11 Power Tool Cleaning to Bare Metal  
 SSPC-SP 14/NACE No. 8 Industrial Blast Cleaning  
 SSPC-SP 15 Commercial Grade Power Tool Cleaning  
 SSPC-SP 16 Brush-Off Blast Cleaning of Non-Ferrous Metals  
 SSPC-SP WJ-1/NACE WJ-1 Clean to Bare Substrate  
 SSPC-SP WJ-2/NACE WJ-2 Very Thorough Cleaning  
 SSPC-SP WJ-3/NACE WJ-3 Thorough Cleaning  
 SSPC-SP WJ-4/NACE WJ-4 Light Cleaning  
 SSPC-PA 1 Shop, Field and Maintenance Painting of Steel  
 SSPC-PA 2 Procedure for Determining Conformance to Dry Coating Thickness Requirements  
 SSPC-PA Guide 11 Protecting Edges, Crevices, and Irregular Steel Surfaces by Stripe Coating  
 SSPC-PA 17 Procedure for Determining Conformance to Steel Profile/Surface Roughness/Peak Count Requirements  
 SSPC-VIS 1 Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blasting  
 SSPC-VIS 5/NACE VIS 9 Guide and Reference Photographs for Steel Surfaces Prepared by Wet Abrasive Blasting  
 SSPC-VIS 3 Guide and Reference Photographs for Steel Surfaces Prepared by Hand and Power Tool Cleaning  
 SSPC-VIS 4/NACE No. 7 Visual Standard for Steel Cleaned by Water Jetting  
 SSPC Paint 27 Basic Zinc Chromate-Vinyl Butyral Wash Primer  
 SSPC Guide 6 Guide for Containing Debris Generated During Paint Removal Operations  
 SSPC Guide 7 Guide for the Disposal of Lead Contaminated Surface Preparation Debris  
 SSPC Guide 15 Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Surfaces

#### 2.4 ~~International Standards Organization (ISO):ISO Standards:~~<sup>7</sup>

ISO 8501-4 Preparation Grades and Flash Rust Grades in Connection with High-Pressure Water Jetting  
 ISO 8502-3 Preparation of Steel Substrates before Application of Paints and Related Products – Tests for the assessment of surface cleanliness

2.5 ~~NACE International (NACE):International:~~<sup>5</sup> SP0178-2007 (formerly NACE RP0178) Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to be Lined for Immersion Service

#### 2.6 *ASTM Adjuncts:*

Pictorial Surface Preparation Standards for Painting Steel Surfaces <sup>8</sup>

### 3. Significance and Use

3.1 This guide is intended as a reference for those concerned with the inspection of industrial coating work. The requirements for inspection should be addressed in all protective coating and lining work specifications. This guide may be used by specification writers when selecting and establishing the inspection requirements for coating and lining specifications. A checklist for use by inspectors in the field is included in **Appendix X1**.

### 4. Preparation for Inspection

4.1 The guide describes the duties of the inspector and discusses inspection methods, both visual and instrumental, that can be used to determine that the specification requirements have been met by the painting contractor.

4.2 Before painting is started the project engineer should provide the inspector with information from the official plans and specifications as to coating type, thinner to be used, mixing ratios to be used, specified application thickness, primer, tie coat,

<sup>7</sup> Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, <http://www.iso.org>.

<sup>8</sup> The pictorial surface preparation standard Method A (ISO/Swedish Standard) is available from ASTM International Headquarters. Request Adjunct No. **ADJD2200**.

topcoat, time between coats, surface preparation, method of application, and any special precautions to be followed such as limits on ambient conditions. These details should be recorded in an inspector's record book to eliminate any misunderstanding between the inspector and the contractor.

4.3 The inspector should obtain copies of the Safety Data Sheets (SDS) for all products that will be used on the project, review any hazard communications program in accordance with 29 CFR 1926.59 that will apply to the project, and review other safety information related to the work that will be performed by the contractor. The inspector should examine these materials and be supplied with appropriate protective equipment and devices.

4.4 The Product Data Sheets (PDS) for the coating products to be used, including thinners where applicable, shall be provided with the procured product. Note that the coating specification may allow only specific pre-qualified coatings to be used.

## **5. Surface Preparation Methods and Requirements**

5.1 *Surface Preparation* is one of the most important factors affecting the performance of coatings. The specifier determines the proper level in accordance with the expected service life and type of coating specified.

5.1.1 *Pictorial Standard D2200 (SSPC-VIS 1)* should be provided to the inspector on a job involving blast cleaning of structural steel. The standard is used by the inspector to assist in determining whether the degree of surface preparation specified in a contract has been attained by the contractor. For large jobs it is recommended that before work starts, an actual steel sample of adequate size be blasted to the satisfaction of the project engineer. This blasted surface should be protected by a clear acrylic coating or encased in plastic and used for reference purposes as the work progresses.

5.2 *Factors Affecting Coating Performance*—There are a number of factors that should be considered to ensure a proper painting job.

5.2.1 *Cleanliness*—Many materials, if not removed from the surface, will affect the life of the coating. These include oil, grease, soil, weld spatter, and slag, that make it impossible to obtain proper adhesion to the metal surface. Surface soluble salts shall be removed to the degree specified or long term coating performance may be adversely affected. SSPC/NACE issues detailed surface preparation specifications that cover various methods for cleaning.

5.2.2 *Mill Scale*, The bluish-black oxide resulting from the hot-rolling process, is a constant source of trouble leading to coating failure. This scale is very brittle and can crack or loosen due to temperature changes (both in fabricating and weathering in the field) leading to failure of the coating.

5.2.3 *Surface Profile*—The texture of the metal surface has a significant effect on the performance of coatings, since it increases the surface area to which the coating can develop adhesion. In fact, the term “anchor pattern” is sometimes used to describe the depth of profile. Profile varies both with the type and size of the abrasive used. Coarser abrasives generally produce a coarser and deeper profile. Deep profiles are advantageous for adhesion, but require more coating to fill in the valleys and cover the peaks of the profile; they cannot be used with low-build coatings that do not cover the peaks even when several coats are applied. The angularity (sharpness) and density of the profile may affect adhesion. Methods for measuring surface profile can be found in Test Methods **D4417** and **D7127**. Frequency of surface profile measurement and the acceptability of the measurements is described in SSPC-PA 17.

5.2.4 *Sharp Edges*—Sharp edges and rough welds can compromise coating performance, particularly in immersion service. Sharp edges and outside corners should be radiused, and rough welds should be smoothed or ground flat. NACE SP0178 and SSPC-PA Guide 11 may be used as guides. This operation should be specified during fabrication, but is frequently done by the coating contractor. The coating inspector should verify that such work has been done, if required by the coating job specification prior to other steps in surface preparation.

5.3 *Cleaning Procedures*—Safety precautions are not addressed separately for each of the following cleaning methods. Each has its own safety-related hazards, and U.S. Occupational Health and Safety Administration regulations should be followed. Safety Data Sheets (SDS) for the solvents and cleaning compounds provided by the manufacturer should also be consulted for proper worker protection.

5.3.1 *Chemical Cleaning*—Solvents are used to remove oil, grease, and related materials. The solvent is applied to the surface by wiping or scrubbing with rags or brushes. The contaminants should be removed (not simply spread out) by a thorough wiping of

the affected areas with cloths saturated with clean solvent. Contaminated cloths should not be dipped into clean solvent. The cleaning should be repeated with clean rags and fresh clean solvent. Emulsions, cleaning compounds, steam cleaning, or similar methods and materials may also be used. Where emulsion cleaners, soaps, or detergents are used, they should be removed completely by washing with clean hot water. SSPC-SP 1 covers cleaning procedures using these materials.

5.3.1.1 *Solvent Vapor Cleaning* is a procedure that can be adapted to a production line or piecework operation. Vapor cleaning removes all soluble contaminants but does not disturb the natural oxide film. If this film should be removed, mechanical cleaning will be necessary as well. The part to be cleaned is placed in the saturated vapor above the heated solvent so that the solvent vapor condenses on the metal surface. Vapor degreasing does not remove particulate matter, so parts should be wiped to remove any insoluble soils. Vapor degreasing has the advantages over solvent wiping in that hot solvents are used and the solvent condensation removes oils without recontamination.

5.3.2 *Hand Tool Cleaning* is the method used for the removal of loose mill scale, loose rust, loose or otherwise defective coating, weld flux, slag and spatter from metal surfaces by hand brushing, hand sanding, hand chipping or scraping using wire, fiber or bristle brushes, sandpaper, steel wool, hand scrapers or chisels, and chipping hammers. Material is considered tightly adherent if it cannot be lifted with a dull putty knife. SSPC provides a detailed specification, SSPC-SP 2. A visual standard, SSPC-VIS 3, may be used to assist in determining compliance.

5.3.2.1 Hand tool cleaning requires that all weld flux, tar, oil and grease, and other greasy contaminants be removed first by solvent cleaning (5.3.1).

5.3.2.2 Wire brushes should be rigid enough to clean the surface thoroughly, and shaped to penetrate into all corners and joints. Brushes should be kept free of all materials that may clog the wires of the brush.

5.3.2.3 Hand scrapers should be made of tool steel, tempered and ground to a sharp edge, and should be of the proper size and shape to enable cleaning to be done as specified. Scrapers should be kept sharp at all times.

5.3.3 *Power Tool Cleaning* is a method used for the removal of loose mill scale, loose rust, loose or otherwise defective coating, and weld flux from metal surfaces by power wire brushes, power impact tools, power grinders, power sanders, or by a combination of these methods. Material is considered tightly adherent if it cannot be lifted with a dull putty knife. SSPC-SP 3 is the detailed specification for power tool cleaning. A visual standard, SSPC-VIS 3, may be used to assist in determining compliance.

5.3.3.1 Power tool cleaning requires that all oil, grease, weld flux, and other contaminants be removed first by solvent cleaning (5.3.1). Hand tool cleaning in accordance with 5.3.2 may be used prior to power tool cleaning.

<https://standards.iteh.ai/catalog/standards/sist/968dc7e2-9c48-473c-940b-d435f8cfl fid2/astm-d3276-21>

5.3.3.2 All equipment should be suitable for the configuration of the work to be cleaned and maintained free of material that clogs the wire or disks making them ineffective. All impact tools should be kept sharp.

5.3.4 *Power Tool Cleaning to Bare Metal* is a method used for the total removal of coating, rust, and mill scale. It also requires a minimum of 1-mil anchor profile. Surface cleaning, power tools, and surface profile producing media are used to obtain the specified finish. Surface cleaning power tools consist of non-woven abrasive wheels and discs, coated abrasive discs or sanding pads, coated abrasive fly wheels, and coated abrasive bands. Surface profile producing media consist of rotary impact flap wheel assemblies and needle guns. SSPC-SP 11 is the detailed specification for power tool cleaning to bare metal.

5.3.4.1 Depending on the initial condition of the surface and existing profile conditions, it may be necessary to use one or both

**TABLE 1 Comparison of Surface Preparation Standards**

Preparation Guide	SSPC	ASTM D2200		NACE
		Method A <sup>A</sup>	Method B <sup>B</sup>	
Blast clean to white metal	SSPC-SP 5	Sa 3	SP 5	1
Blast clean to near-white metal	SSPC-SP 10	Sa 2½	SP 10	2
Commercial blast cleaning	SSPC-SP 6	Sa 2 <sup>C</sup>	SP 6	3
Brush-off blast cleaning	SSPC-SP 7	Sa 1	SP 7	4
Industrial blast cleaning	SSPC-SP14	...	...	8

<sup>A</sup> Method A is ISO/Swedish Standard.

<sup>B</sup> Method B is SSPC- VIS-1.

<sup>C</sup> Pictorial Standard Sa 2 shows mill scale and conflicts with SSPC definition of commercial blast (SP 6), which does not allow mill scale.

**TABLE 2 Comparison of Water Jetting Standards**

Cleanliness Description	SSPC/NACE	ISO
Clean to Bare Metal	SSPC-WJ-1/NACE WJ-1	Wa 3
Very Thorough Cleaning	SSPC-WJ-2/NACE WJ-2	Wa 2.5
Thorough Cleaning	SSPC-WJ-3/NACE WJ-3	Wa 2
Light Cleaning	SSPC-WJ-4/NACE WJ-4	Wa 1

of the types of power tools. All oil, grease, weld flux, and other contaminants should be removed first by solvent cleaning (5.3.1). Hand tool cleaning (5.3.2) or power tool cleaning (5.3.3) may be used prior to power tool cleaning to bare metal.

5.3.4.2 All equipment should be suitable for the configuration of the work to be cleaned and maintained free of material that clogs the wire or discs making them ineffective. For example, needle guns require ~~2-mm~~ 2 mm diameter needles to produce a suitable surface profile.

5.3.4.3 The finished surface should be bare, bright metal. Slight residues of rust and paint may remain in the lower portions of pits if the original surface was pitted. SSPC-VIS 3 is a visual standard to assist in determining compliance. Surface profile is determined by procedures in 10.1.1.

5.3.4.4 *Commercial Grade Power Tool Cleaning, SSPC-SP 15* is performed in a manner similar to SSPC-SP 11. The finished surface should be bare, bright metal. Staining is allowed on 33 percent of the evaluation unit area, and slight residues of rust and paint may remain in the lower portions of pits if the initial surface was pitted. It also requires a minimum of ~~1-mil~~ 1 mil anchor profile.

5.3.5 *Blast Cleaning* is used to remove coating, rust and mill scale from a metal surface and to provide a roughened surface by striking the surface with a stream of small, hard abrasive particles such as (dry) sand, grit, or shot.

5.3.5.1 One method utilizes compressed air, special blast nozzles, and abrasive. Water may be injected into the air stream to control dust, and a rust inhibitor may be needed (5.3.6). In another method used primarily in fabricating shop, wheels propel the abrasive centrifugally against the work. The minimum and maximum particle size of the abrasive may be specified as a means of controlling the surface profile. The particle size can be verified by sieve test in accordance with Test Method D6913.

5.3.5.2 Blast cleaning requires that all oil, grease, and weld flux be removed by solvent cleaning (5.3.1). The compressed air used for blast cleaning should be free of condensed water or oil by making certain that separators and traps are in working order. Test the compressed air supply in accordance with Test Method D4285. The abrasive material should be free of soluble contaminants when tested in accordance with Test Methods D4940, D7393, or the appropriate SSPC abrasive specification (AB 1, AB 2, AB 3, or AB 4) for the type of abrasive material.

5.3.5.3 Blast-cleaning operations should be performed so that no damage is done to the completed portion of the work. Blast cleaning is often performed from the top to bottom of the structure and should only be carried on downwind from any recently painted areas. Dry blast cleaning operations should not be conducted on surfaces that will be wet after blasting and before painting. Steel temperature should be at least  $3^{\circ}\text{C}$  (~~5<sup>o</sup>F~~) 3 °C (5 °F) above the dew point temperature.

5.3.5.4 The degree of blast cleaning required should be at least equal to the appropriate surface preparation specification and the applicable visual standard. Standards from ASTM, SSPC, and National Association of Corrosion Engineers (NACE) are listed in Table 1. Note that Pictorial Surface Preparation Standards D2200 is divided into two methods for abrasive blasting. Method A describes photographic standards available from International Standards Organization (ISO) Pictorial Surface Preparation Standards. Method B describes photographic standards available from SSPC. The two sets of photographs are not directly comparable.

5.3.5.5 Blast cleaned surfaces should be examined for any traces of oil, grease, or smudges; where present, the contaminants should be removed by solvent cleaning (5.3.1). Surfaces that have been dry blasted should be brushed with clean brushes, blown with compressed air free of oil and moisture, or vacuum cleaned to eliminate any traces of blast products, dust, or dirt from the surface. This also serves to remove abrasive from pockets and corners.

5.3.5.6 Blast cleaned surfaces should be further treated, primed or painted on the same day they are blasted, preferably within 8 h, or in any event before any visible flash rusting occurs. Reblasting will be necessary on any surface if rust bloom forms before coating can be applied.