A Primer on Paint Systems for Steel Structures

By Thomas J. Schlafly

Part 1 – Proper Selection and Specification

Steel structures serve a wide variety of purposes, and exist in an equally wide variety of environments. Steel has been used for over 100 years in enclosed commercial buildings and exposed railway and highway bridges. One pervasive concern of the builders of these structures is their durability over time. Another is appearance. Some have an affinity for the appearance of industrial strength and raw power evoked by bare steel surfaces. Others want to use color to express their vision for the structure.

The coatings and corrosion protection industry is as vast and varied as the uses of steel. There are many standards and practices, and they differ in various industries and applications. The standards and practices discussed here are those that are commonly used with the fabrication of new structural steel, designed and furnished to the requirements of the AISC *Specification for Structural Steel Buildings and the AISC Code of Standard Practice*. This is an introductory summary of selected practices and standards. The reader is encouraged to review the standards referenced, as this summary cannot replace them.

Appearance and durability of steel can be addressed in a number of ways. Leaving the steel bare is an option that works for most enclosed structures that are not subject to chemical attack (office, commercial, etc.). Structures exposed to normal weather can be made durable through the use of weathering steel. Galvanizing is also an option where its appearance is acceptable; it is particularly useful when the requirements are relatively high. Metallizing is a possibility that is currently being considered by some State Departments of Transportation. By far, the most common corrosion protection method is the use of paint.

Paint System Selection

The three primary factors in the selection of a paint system are environmental effects on durability (exposures), appearance requirements, and cost (both initial cost and life cycle cost). In many cases, the variables in these areas are not clear or distinct.

Where corrosion protection is the goal, one must first consider the environment and the forces causing the corrosion. The Society for Protective Coatings (SSPC) recently updated their guidance for coating system selection. Chapter 1 in the SSPC Painting Manual (Systems and Specifications Vol. 2), defines environmental zones and recommends paint systems for those zones. This information is included here in *Table 1* and *Table 2*. Note that steelwork enclosed in building finishes in non-corrosive areas is sometimes left unpainted. The surface condition of such steel framing in many longstanding buildings has been excellent, except in isolated spots where leakage may have occurred. Where such leakage is not eliminated, the presence or absence of a shop coat is considered of minor influence.

Basic guidance for proper paint system selection is summarized in *Table 3*. Other physical characteristics that pertain to paint system selection include abrasion resistance, graffiti resistance, gloss retention, restrictions due to environmental issues (VOC content), slip resistance and compatibility with fireproofing or fire resistance of the coating itself.

Abrasion Resistance

Urethane coatings have more abrasion resistance per mil than other organic generic types. Epoxies can be formulated to resist abrasion. Zinc-rich coatings tend to burnish or polish but usually do not abrade from the surface.

Graffiti Resistance

Some urethanes and polyester urethanes are specially formulated to resiststst graffiti.

Table 1: SSPC Environmental Zones

0	Dry interiors where structural steel is imbedded in concrete, encased in masonry or protected by membrane or non-corrosive contact type fireproofing.
1A	Interior, normally dry (or temporary protection). Very mild (oil base paints now last six years or more.)
1B	Exteriors, normally dry (includes most areas where oil base paints now last six years or more.)
2A	Frequently wet by fresh water. Involves condensation, splash, spray or frequent immersion (Oil base paints now last 5 years or less.)
2B	Frequently wet by salt water. Involves condensation, splash, spray or frequent immersion. (Oil basepaints now last 5 years or less.)
2C	Fresh water immersion.
2D	Salt water immersion.
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 solvents. Intermittent contact with aliphatic hydrocarbons (mineral spirits, lower alcohols, glycols, etc.)
3E	Chemical atmospheric exposure, severe. Includes oxidizing chemicals, strong solvents, extreme pH's or combination of these with high temperatures.

Gloss Retention

Gloss retention varies with the pigment used. Coating manufacturers can show the results of ASTM D523 (*Test Method for Specular Gloss*) and ASTM D2244 (*Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates*) when applied to samples subject to ASTM D5894 (*Practice for Cyclic Corrosion/UV Exposure of Painted Metal*) to indicate a coatings color and gloss performance. Gloss retention of 70 percent and a delta e of 3 are usually considered good performance for gloss and color uniformity.

VOC Content

The Environmental Protection Agency (EPA) places limits on emissions from industrial facilities that depend on where the facility is located. Because of those limits, some shops and painting facilities may have more reason than others to use coatings with lower volatile organic compound (VOC) content. Since lower VOC content is better for all of us, using environmentally friendly coatings is a good choice whenever they are suited to the purpose. Water-borne coatings continue to develop and should be considered.

Slip Resistance

Slip resistance is an issue that comes in two forms: slip resistance in bolted connections and slip resistance of walking and working surfaces.

The RCSC *Specification for Structural Joints Using ASTM A325 and A490 Bolts* provides a test for classifying coatings into class A or class B, and permits classified coatings to be used on the faying surface of slip-critical joints. Many inorganic zinc-rich primers meet the requirements for Class B surfaces. Alkyds, epoxies and urethanes are not intended for slip resistance in bolted connections; nor are they usually tested for it. Coatings that are not qualified in accordance with the RCSC Specification are not permitted on the faying surface of slip-critical joints.

Slip resistance for walking and working surfaces is occasionally an issue. When it is a consideration, coating suppliers have special formulations for the purpose. These formulations commonly include a solid component such as polyethylene beads that increase the slip resistance. These formulations may not be suitable for all applications. Slip resistance of structural steel for safety during erection may be a consideration in future work, depending upon the outcome of OSHA deliberations on this matter.

Compatibility with Spray-applied Fire-Resistive Materials

Spray-applied fire-resistive materials are usually applied in the field to bare steel. If the steel is to be coated prior to fireproofing, the compatibility of the coating with the fireproofing to be used must be demonstrated. The manufacturer can provide compatibility information to assist the specifier in avoiding the common case of fireproofing that is not compatible with – and will not adhere to – coated surfaces.

Table 2: Environmental Zones for which SSPC Painting Systems are Recommended (excerpt from SSPC Table 3)

Painting System		Environmental Zone (from Table 3)											
SSPC #	Generic Type	0	1A	1B	2 A	2B	2C	2D	3A	3B	3C	3D	3E
PS 1	Oil Base		X	X									
PS 2	Alkyd		X	X									
PS 3	Phanolic (oleoresinous)		X	X	X								
PS 4	Vinyl		X		X	X	X	X	X	X			
PS 7	One-coat shop	X	X										
PS 9	Cold-applied asphalt mastic				X	X				X	X		
PS 12	Zinc-rich (un-topcoated)		X	X	X	X	X	X		X		X	
PS 12	Zinc-rich (topcoated)		X	X	X	X	X	X	X	X	X	X	X
PS 13	Epoxy-polyamide (non-immersion)**				X	X							
PS 14	Steel joist shop paint		X										
PS 16	Silicone alkyd				X								
PS 17	Urethane		X	X	X	X				X	X		
PS 18	Latex		X	X									
PS 22	One-coat preconstruction		X	X									
CS 23	Thermal spray metallic		X	X	X	T	X	T	T	T	T		
PS 24	Latex (performance based)		X	X	X	X			X	X	X	X	
PS 26	Aluminum epoxy (performance based)		X	X	X*	X*							
PS 27	Alkyd (performance based)		X	X	X*	X*							

Notes:

- *Zones for use are those recommended by the committee that developed the specification.*
- *PS 4 (vinyl) and PS 15 (chlorinated rubber) do not meet VCC restrictions and are rarely used.*
- *** For immersion service, proprietary epoxy and urethane coatings are usually used.*
- *T = Recommended only with proper sealing or topcoating.*
- *PS 26 and PS 27 are material specifications and cover only the paint.*
- *X* = Excluding immersion*
- *For Zone 3E use specific exposure data to select a coating.*
- *Because more than one system is recommended for a particular zone does not mean that they will all perform equally well.*

Table 3: Coating/System Types			
	Uses	**Advantages**	**Limitations**
Oil (Linseed oil based with rust inhibitive pigment)	Exterior atmosphere, usually over coated with alkyd	Surface tolerant SP2 or 3	Slow dry, limited resistance to chemical abrasion
Alkyd	Industrial atmospheres too severe for oils	Ease of application Good wetting Relatively inexpensive. From renewable source	Poor chemical resistance Poor immersion resistance Long cure
Vinyl	Severe exposure, some corrosive chemical contact		Dissolved by aromatics, keytones ethers and esters. Attacked by some acids. High VOC content SP6 or SP10 4 coats
Polyurethanes		Low VOC available Good water resistance Good hardness or flexibility Good abrasion resistance Low temp cure available Some have good color and gloss retention	Blast required Toxic High operator skill Limited pot life
Epoxy		Low VOC possible Solvent and water resistant Good abrasion Good adhesion	Chalk in sunlight Limited flexibility Limited pot life Blast required
One-coat shop systems	Dry interiors where temperature rarely falls below dew point and RH is rarely above 70%	SP2 acceptable	Not suitable for severe exposures
Zinc-Rich Primers Type I Inorganic Type II Organic	High humidity, fresh water immersion. With proper topcoat they may be exposed to chemical fumes	Good abrasion resistance Corrosion protection through galvanic action. Usually classified as a class B surface for slip critical connections.	Blast required Operator skill Inorganic zincs require humidity to cure Curing before top coating needs to be assured Limited color selection (Organic is less sensitive to application. Un-topcoated it provides less abrasion resistance and galvanic action.)

Fire-resistant Coatings

Paint-like fire-resistant coatings are currently available, and more are in development. In their current form, they are used primarily in off-shore oil structures and other specialty applications. In commercial structures, they are becoming more popular for applications where architecturally exposed structural steel is specified, or when fire-resistant enclosure or spray-on fireproofing is not desirable. These coatings can be, and in some cases are required to be, applied in thicknesses up to 400 mils.

Specifying Coatings

Coatings should be thought of as systems. Some systems work in single coats, others perform well in multiple-coat applications. Some coatings demand specific levels of surface preparation, while others are more tolerant of surface conditions and permit less demanding surface preparations. There are three methods to specify coatings: approved products, performance requirements or chemical requirements.

For a relatively economic shop primer, a specification might include a minimum surface preparation such as SSPC SP2 or SP3, one or more approved coatings and the thickness of the coating perhaps 1½ to 2 mils dry-film thickness (DFT). Such a system might be well suited to preventing corrosion during construc-tion, though such treatment is not required if a subsequent top-coating is not required.

A system that is intended to prevent corrosion for a longer period and provide an attractive appearance demands a more sophisticated specification, which might include:

i. Minimum condition of the substrate: This may include a minimum acceptable rust grade for the parent material such as SSPC rust grade C. It may include a prohibition against weld spatter and or a requirement to relieve sharp corners. *See substrate condition in part 2 of this article*. Special architectural require-ments may be included.

ii. Surface preparation: Usually SSPC SP2, SP3, SP11, SP7, SP6, SP10 or SP5. This may include specific profile depth or abrasive requirements.

iii. Masking requirements: Perhaps 2 inches around the faying surfaces of slip critical connections, 2 inches around areas where field welding will occur, and on surfaces that will be embedded in concrete. Masking of areas for field welding may be larger if coordination of the field weld location is not clear when the piece is detailed.

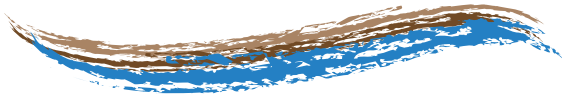
iv. Special application conditions may include minimum surface or ambient air temperature, and refer to SSPC PA1

v. Coatings and thicknesses: this will typically include a list of specific approved coatings and may include a statement that other brands may be approved.

vi. Finish color

vii. Specific quality control requirements: this may include specific requirements for measurement and recording of ambient air temperature, surface preparation, and coating thickness. It may refer to SSPC PA2.

The foregoing items are addressed in greater detail in the SSPC Painting Manual.▪



Part 2 Application, Quality Control and Other Issues

Application

Proper application related primarily to four topics: substrate condition, surface preparation, mixing and coating application.

Substrate Condition

As molten steel solidifies, it forms a scale on the surface. The scale is an oxide with a fairly smooth surface, and it typically corrodes more slowly than the underlying steel. It will dislodge under mechanical pressure and some will become loose after routine ambient air temperature cycles. Steel will start to corrode where the scale has been removed in as little time as a few hours to a few days, depending on the surrounding conditions. If the steel has been exposed for a very long period of time, it will begin to corrode unevenly and pits will form.

Photo by Tom Calzone

SSPC has developed 4 categories of surface corrosion to use in evaluating the condition of bare steel. The rust grades are discussed in SSPC Painting Manual Vol. 2, and visual depictions are available in SSPC VIS 1. It is common to prohibit the use of steel with rust Grade D (steel surface completely covered with rust: pitting visible). This is almost certainly not a concern for new steel structures.

Weld spatter is a condition where metal particles expelled during fusion welding adhere to the surface adjacent to welds. SSPC surface preparations SP2 and 3 make no mention of spatter, and the other abrasive blast standards do not demand removal of spatter but refer to the project specifications. Spatter forms surface irregularities that are not in themselves detrimental, but may interfere with consistent coverage or may come off in the future leaving pinholes. Spatter is commonly left on steel coated with simple shop primers for interior use, but is frequently removed when the steel is to be coated with more sophisticated coatings.

Coatings form a surface tension as they cure. That surface tension will pull some coatings away from sharp corners. A study conducted in the late 1990s by the National Steel Bridge Alliance (NSBA) demonstrated that the phenomenon does not occur with all coatings. Many inorganic zinc coatings typically do not exhibit problems due to sharp corners. Where sharp corners are perceived to be a problem, the surface adjacent to them can be given an extra preliminary coat (striped) or the corners can be eased with a grinder.

Because both of these operations have costs associated with them, if a treatment is required for sharp corners, it should be clear in the contract documents what corners must be so treated. Most often cut corners are sufficient. The corners formed by hot rolling at the mill do not usually demand special treatment.

Hollow structural sections (HSS) have seams; wide flange shapes have mill identifications rolled into them as a provision of ASTM A6. Hot-rolled steel is not produced to meet architectural surface requirements. Therefore, it can be shipped with surface defects as long as they are not detrimental to performance. Limits to surface defects are defined in ASTM A6. Remedial work to remove or cover seams, marks and defects can be done, but it has costs associated with it and the results vary. Appearance can be improved in some cases, such as with the seams on HSS, by locating the mark away from the prevalent field of view.

Surface preparation

Surface preparation standards are published by SSPC. Visual representations of abrasive blast standards are available in SSPC VIS 1. Visual representations of hand and power tool cleaning are available in SSPC VIS 3. Surface preparation standards that are commonly used in commercial steel frames are described in *Table 4*. Other methods and standards for surface preparation are available and used for specific applications.

Some coatings are meant to be surface tolerant, which means they will adhere to tight scale. These paints are typically used for interior service or maintenance of structures that are not subject to severe exposure. Other coatings will not adhere to scale or oxides, and they must be used on steel that has had the surface prepared in a more sophisticated manner. The surface preparation selected must meet the requirements of the coating manufacturer

Higher levels of cleaning are associated with higher costs. Abrasive blast cleaning can be done using a handheld blast nozzle, but is more commonly done in a rotary blast machine. Smaller pieces are placed on a 'sled' or in racks, and blast cleaned many pieces at a time. Large pieces are cleaned one at a time. Blast machines are large investments and they require frequent maintenance. Since there is usually only one such machine in the shop, it can be on the critical path for some projects. Higher degrees of surface preparation can be achieved by operating the machine slower or putting the piece through multiple times.

Other variables that may be considered in blasting include the selection of abrasive media (usually steel grit or shot), media size and the resulting surface profile depth.

Mixing

Preparing the coating for application appears simple but can have pitfalls associated with it. Zinc coatings often come with the zinc powder in a separate container. Coatings can come in two or more parts. Blending the components in the proper proportions is essential

as is using clean containers, components that have not exceeded their shelf life, adequate agitation and giving some paints the required induction time.

Coating Application

SSPC PA1 provides a detailed set of procedures for paint application. The most frequent application methods used in structural steel shops are conventional and airless spray. Application of a uniform coat of the proper thickness requires concentration on the part of the painter. Wide flanges are relatively complex shapes for the purposes of achieving a uniform coat. The addition of detail material makes them more complex. Maintenance and cleanliness of the gun tips and hoses is critical to achieving a uniform coating without drips and sags. A proper spray pattern and technique helps provide a uniform coat. A good painter is aware that wet coatings will sag and the lower part of a flange at the fillet will tend to have a thicker coat than the flange toes.

With high-performance coating systems, special care may be necessary to assure the area behind corner clips and in boltholes are painted. These can be applied by daubing.

Quality Control

All coating systems need some quality control, though the extent of measurements and recordkeeping has to vary with the demands of the coating system. Simple one-coat shop primers must be stored properly and not kept beyond their shelf life. The ambient air temperature must be measured and recorded to assure it is above the minimum. The steel surfaces must be visually inspected to assure they are free of oil grease, loose scale, loose rust and other foreign matter. The painted material must be visually inspected, and the dry film thickness checked to assure the pieces are completely coated and the thickness is within range. More sophisticated systems demand more extensive controls

Material control

Coating components have to be stored properly and should not be used if their shelf life has been exceeded. Containers are labeled and should not be open until the coating is used. Containers are usually stored in weather-tight areas where the temperature is kept between 40º F and 100º F. Some coating components can tolerate freezing, but many cannot. It is appropriate to keep records of the use of coating batch numbers and pieces painted when applying high-performance systems

Environmental Controls

Steel surface temperature, relative humidity and ambient air temperature all are measured frequently enough to provide assurance application is conducted in specified conditions. Coating should not be applied outside the range of temperatures indicated by the manufacturer, or when the surface is less than 5º F above the dew point temperature. Some coatings require a minimum humidity to cure. This is usually controlled by evaluating the cure, and misting the painted surface if the humidity is determined to be low enough to deter curing.

Surface Preparation

The steel is visually inspected after blast cleaning and before painting to ensure the material ready for coating meets the criteria for the blast standard specified, and the abrasive is completely removed from the surfaces. Corners around detail material demand attention, as they 'shade' the surface from the full effect of the abrasive blast and trap abrasive. Blasting removes scale and in doing so reveals or forms fins and tears. Prior to painting, the fins or tears need to be repaired by grinding, or grinding and welding. If the repairs are extensive, the piece may have to be re-blasted. Some coatings or projects require a surface profile in a specified range of depths. Profile is evaluated using a visual comparator with a magnifier, or with replica tape that is pressed to the

Table 4: Surface Preparation		
SPCC Standard Designation	**Name**	**Description and Comments**
SP1	Solvent Cleaning	Is a chemical method for removing all visible oil, grease, soil, drawing and cutting compounds and other soluble contaminants from steel surfaces. (This standard is required by all of the subsequent listed standards.) (Water soluble drilling may not have to be removed by chemicals.)
SP2	Hand Tool Cleaning	Removes all loose mill scale, loose rust, loose paint and other loose detrimental foreign matter. It is not intended that adherent mill scale, rust and paint be removed by this process. Mill scale and rust are considered adherent if they cannot be removed by lifting with a dull putty knife.
SP3	Power Tool Cleaning	Removes all loose mill scale, loose rust, loose paint and other loose detrimental foreign matter. It is not intended that adherent mill scale, rust and paint be removed by this process. Mill scale and rust are considered adherent if they cannot be removed by lifting with a dull putty knife.
SP11 (not common in new steel fabrication)	Power Tool Cleaning to Bare Metal	Surfaces viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxide, corrosion products and other foreign matter. Slight residue of rust and paint may be left in the lower portion of pits if the original surface is pitted.
SP7	Brush-Off Blast Cleaning	Surfaces viewed without magnification, shall be free of all visible oil, grease, dirt, dust, loose mill scale, loose rust and loose coating. Mill scale and rust are considered adherent if they cannot be removed by lifting with a dull putty knife after abrasive blast cleaning has been performed. The entire surface shall be subject to the abrasive blast.
SP6	Commercial Blast Cleaning	Surfaces viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, coating, oxide, corrosion products and other foreign matter except for staining. Random staining shall be limited to no more than 33% of any unit area (see standard) and may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale or stains of previously applied coating.
SP10	Near-White Blast Cleaning	Surfaces viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, coating, oxide, corrosion products and other foreign matter except for staining. Random staining shall be limited to no more than 5% of any unit area.
SP5	White Metal Blast Cleaning	Surfaces viewed without magnification shall be free of all visible oil, grease, dirt, dust, mill scale, rust, coating, oxide, corrosion products and other foreign matter.

blasted surface and then measured with a micrometer. Finally, surfaces to be painted must be dry.

Thickness measurement

Thickness of the applied coating is correlated to the service life of the coating. Each coating has a minimum thickness required to provide the anticipated service. Some coatings have a maximum thickness beyond which they may crack, split, not cure or otherwise not perform. The minimum thickness or thickness range for each coat must be specified in the contract documents. The coating manufacturer will show thickness information on the product data sheet.

Film thickness is measured wet and dry. The wet film thickness is measured with a simple gage that has prongs at differing levels. After being placed against the wet surface, the highest prong with paint on it indicates the wet thickness. Wet film is usually measured by the painter in order to evaluate the work in progress so it can be corrected as the work is done. The required wet thickness is a function of the required dry thickness and the percent of the coating that is solids. Note that wet film thickness is not considered useful for all coatings. For example, zinc-rich paints contain such a high percentage of zinc, and achieve an initial set so quickly, that measuring the wet film is not usually done. Wet film is not usually recorded as a QC measurement.

Dry film thickness is measured with any of a variety of gages. The gages have to be verified for accuracy before each use, and they are set relative to the steel profile being coated.

Dry film thickness is the measurement that is recorded for quality control. Therefore, measurements are taken in accordance with a sampling procedure and recorded. In structural steel shops, a person using a spray gun with a manually controlled pattern applies paint. The painter is trained to achieve a relatively uniform coating, accounting for the position of the elements of the piece and the characteristics of the coating. In the best of conditions, film thickness still varies. The extra precautions taken to assure coverage around protrusions and

in corners result in high thickness. Coatings sag and protrusions shade areas causing thin spots. The normal pattern of spray may tend to leave some places thicker than others. As a result, film thickness is measured in a number of places on each piece. To account for variability in thickness three gage readings are taken in an area defined by a 1½-inch circle. Unusually high or low readings are discarded. The average of three acceptable gage readings is considered a 'spot' reading. Spot readings are taken in a number of locations on each group of pieces to be measured. SSPC PA2 includes sampling plans suitable for high-performance coatings.

SSPC PA2 permits individual spot readings slightly outside the specified range. Individual spot readings between 80 percent and 120 percent of the specified range are considered acceptable. The average of the spot readings is to be within the specified range. The most recent edition of SSPC PA 2 has sample plans for different piece types. The base plan calls for 5 spot readings in each 100 square-feet of painted surface area.

There are destructive tests that can be used for special applications. A Tooke gage can be used to measure the thickness of each coat of a multi-coat system. Since these methods are destructive, they are not commonly used in the shop.

Safety

Safety is a significant issue in coatings. Coatings come with material safety data sheets (MSDS). Those working around or with those coatings should be aware of the contents of these data sheets. People working around and with coatings and abrasives must wear personal protective equipment (PPE), which includes clothing to minimize skin contact, goggles, fitted respirators judged to be sufficient for the application and worn properly, and hearing protection. Fire protection safeguards must be maintained.

Other issues:

Follow manufacturer's data sheet

Coating manufacturers can provide an MSDS and a product data sheet with every coating they supply. Frequently, the data sheets are available on the internet. The MSDSs are a requirement for every facility using the coating. The product data sheets contain essential information that is useful in specifying and applying the coating.

Design

Coating structural steel is common but still complex. A great deal can be done to improve the service life of a structure in the design of the project. Selecting details that minimize crevices and pockets that trap coatings and abrasives in the shop, prevent surface preparation application or inspection in the shop, or trap moisture in service can help dramatically. If staining is a problem, using a primer that achieves a class B slip coefficient and coating faying surfaces will help. Continuous welds are better than intermittent welds for paint performance.

References

There are many references on coating selection and application. The Society for Protective Coatings (SSPC) publishes the SSPC Painting Manual. *Volume 1* contains articles on good painting practice and *Volume 2* contains standards for surface preparations coatings systems and painting practices. The National Association of Corrosion Engineers (NACE) also publishes specifications and articles on coatings.▪

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