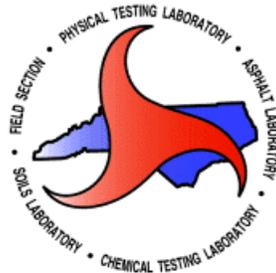


# STRUCTURAL STEEL SHOP COATINGS PROGRAM



**February 4, 2019**

North Carolina Department of Transportation  
Materials and Tests Unit  
Manufactured Products Group

Version 1.0

## **DOCUMENT CONTROL**

The STRUCTURAL STEEL SHOP COATINGS PROGRAM is reviewed during use for adequacy and updated as necessary by the NCDOT Materials and Tests Unit Manufactured Products group.

### **Electronic**

Portable Document Format (PDF) has been selected as the primary distribution format. The official version of the program is available on the NC Department of Transportation website.

### **Hard Copy**

Users who choose to print a copy of the manual are responsible for ensuring use of the most current version.

## REVISION LOG

Revision Date	Description	Approval By
February 23, 2018	<a href="#">Page 16</a> , Incorrect top coat color for System 2. Changed paint color from brown to gray.	SRP/AHD
October 2, 2018	Entire Program	SRP/AHD
December 17, 2018	Entire Program	SRP/AHD
February 4, 2019	Entire Program	SRP/AHD

# CONTENTS

DOCUMENT CONTROL .....	2
REVISION LOG .....	3
INTRODUCTION .....	5
PURPOSE .....	5
SCOPE .....	5
DEFINITIONS.....	5
REFERENCES .....	12
GENERAL INFORMATION .....	14
1.0 PRE-QUALIFICATION .....	15
2.0 REVOCATION OF QUALIFIED STATUS.....	16
3.0 NOTIFICATION OF WORK .....	16
4.0 PRE-JOB MEETING.....	17
5.0 SAFETY.....	17
6.0 STORAGE AND HANDLING .....	17
7.0 PAINT MATERIALS.....	17
8.0 PAINT SYSTEMS .....	18
9.0 PAINTING STEEL STRUCTURES .....	22
10.0 SURFACE PREPARATION.....	22
10.1 Special Attention.....	22
11.0 SPECIFIC COATING APPLICATION .....	25
12.0 INSPECTION.....	26
13.0 COATING REPAIR.....	31
ATTACHMENT 1 .....	33
ATTACHMENT 2 .....	34
ATTACHMENT 3 .....	35

## INTRODUCTION

### PURPOSE

This program is provided to serve as a guide and source of reference for the NCDOT minimum requirements for shop-performed surface preparation, successive coating applications, inspection requirements and touch up repairs of NCDOT-approved coating systems.

Structural steel coating systems are applied to metal surfaces as specified herein when called for on the plans or by other Special Provisions, or when otherwise approved by the Engineer in accordance with the current edition of the specified standards.

### SCOPE

The program affects the fabrication facilities, coaters, NCDOT Materials & Tests office and consultants who are involved in the verification and other quality assurance inspection and testing of steel and miscellaneous metal products.

## DEFINITIONS

**Adhesion:** The degree of attraction between a coating and a substrate or between two coats of paint that are held together by chemical or physical forces or both. Adhesion often is called the “bonding strength” of a coating. Adhesion should not be confused with “cohesion,” which is the force holding a single coating layer together.

**Adhesive Failure:** A failure between two distinct coating layers or between the substrate and the first layer of coating.

**Adjustment (Optimization):** The physical act of aligning a gage’s thickness readings to match those of a known thickness sample (removal of bias) in order to improve the accuracy of the gage on a specific surface or within a specific portion of its measurement range.

**Alligatoring:** (1) A type of crazing or surface cracking of a definite pattern, as indicated by its name. The effect is often caused during weather aging; (2) the cracking of the surface bitumen on a built-up roof, producing a pattern of cracks similar to an alligator’s hide: the cracks may not extend through the surface bitumen. {CED}; surface cracking of a paint film having the appearance similar to alligator hide {ASTM}; alligator cracking is the vertical cracking of a coating with a pattern of closed cells or islands of unbroken coating. See also Cracking.

**Ambient Conditions:** The weather conditions including air temperature, relative humidity, dew point, wind velocity, and air temperature at a specific place and time or time period. These conditions are generally monitored on the job site.

**Ambient Temperature:** The temperature of the surrounding area or environment.

**Applicator (“Shop or Field”):** Person or contractor who applies a coating.

**Area Measurement:** The average of five spot measurements obtained over each 10 m<sup>2</sup> (~100 ft<sup>2</sup>) area of coated surface, or portion thereof.

**Base Metal Reading (BMR):** A measurement obtained on the uncoated substrate using a coating thickness gage.

**Blister:** A dome-shaped defect caused by the formation of gas or liquid under a coating film which results in a localized loss of adhesion and lifting of the coating, i.e. film, from the substrate.

**Blistering:** To raise a bubble or blister formed by trapped gasses or trapped liquid under a cured coating or film.

**Calibration:** The high-level, controlled and documented process of obtaining measurements on traceable calibration standards over the full operating range of the gage, then making the necessary gage adjustments (as required) to correct any out-of-tolerance conditions.

**Certification:** Written testimony of qualification.

**Checking or Crazing:** That phenomenon manifested in paint films by slight breaks in the film that do not penetrate through the last applied coating. See ASTM D660, Standard Test Method for Evaluating Degree of Checking of Exterior Paints.

**Chipping:** Total or partial removal of a dried paint film in flakes by accidental damage or wear during service: in traffic paints, this failure is usually characterized by sharp edges and definite demarcation of the base area {CED}. ASTM D 913 is the Standard Test Method for Evaluating Degree of Resistance of Wear to Traffic Paint. ASTM D 3170 is the Standard Test Method for Chipping Resistance of Coatings.

**Coating:** (1) Liquid, liquefiable, or mastic composition that is converted by evaporation, cross-linking, or cooling to a solid or semisolid protective, decorative, or functional adherent layer after application; (2) the solid or semisolid layer resulting from application of the composition above.

**Cohesion:** The propensity of a substance to adhere to itself. The force holding a substance together. [Painting/Coatings Dictionary] The ability of a single coating layer to resist internal partitioning or fracturing.

**Cohesive Failure:** A failure or break within a given coat or material (the coating breaks within itself).

**Conformance Certification:** A verification issued by the coating manufacturer confirming that a particular batch of product was produced in accordance with the manufacturer's standard. This standard of performance for the product must have previously been approved or accepted by the Owner.

**Corner:** Is the intersection of two surfaces that are not in the same plane.

**Cracking:** (1) The splitting of a dry paint film. Different types of cracking include hair-cracking or hairlines, checking, cracking, crazing, crocodiling or alligatoring, and mud cracking. The Standard test method for evaluating degree of cracking is described in ASTM D 661; (2) To break up into simpler chemical components, as with cracking of petroleum.

**Crazing:** A network of intersecting checks or cracks appearing on a coated surface. See Cracking.

**Crocodiling:** See Alligatoring.

**Curing:** Transformation of a coating or other material into a solid phase or film.

**Curtaining:** See "Sag or Sagging."

**Defect:** Any discontinuity not meeting the acceptance standards of this program.

**Delamination:** Separation of one coat or layer from another coat or layer or from the substrate.

**Detachment:** See Disbonding.

**Dew Point:** The temperature at which air becomes saturated with water, i.e., when the air is at 100 percent relative humidity. Below this temperature, moisture will condense and produce dew or fog. As air is cooled, the amount of water vapor it can hold decreases. Expressed another way, the point where the actual water vapor pressure becomes equal to the saturation water vapor pressure; any further cooling beyond this point normally results in the condensation of moisture.

**Deviation:** Departure of a characteristic from established procedures or specified requirements.

**Direct Visual Examination:** A visual examination technique performed by eye and without any visual aids (excluding light source, mirrors, and/or corrective lenses).

**Disbonding:** The separation resulting from insufficient adhesion of a coating to an undercoating or other substrate.

**Discontinuity:** Void, crack, thin spot, foreign inclusion, or contamination in the coating film that significantly lowers the dielectric strength of the coating film (may also be identified as a holiday).

**Drip:** A drop of wet coating that forms on or falls from the edge of the coated substrate.

**Dry Bulb Temperature:** The temperature recorded by the dry bulb thermometer of a sling or other psychrometer.

**Dry Bulb Thermometer:** The thermometer on a sling or other psychrometer whose bulb is directly exposed to the air (i.e., not covered with a wet sock).

**Dry Film Thickness:** The thickness of a coating (or coating layers) as measured from the surface of the substrate.

**Dry Spray:** (1) A rough, powdery, non-coherent film produced when an atomized coating partially dries before reaching the intended surface; (2) Overspray or bounce back falling dry on unintended surfaces and producing an adherent, sand-like covering.

**Edge:** An exposed, through-thickness surface of a plate or rolled shape. Examples include the as-rolled side face of a beam flange, channel flange, or angle leg; and the cross section of a cut piece resulting from thermal cutting, sawing, or shearing. Edges may be planar or rounded, and either perpendicular or skewed to adjacent faces.

**Edge Grinding (Edge Conditioning):** Very shallow grinding or other pre-blast cleaning preparation of thermal cut edges (TCEs) to remove a thin, hardened layer left by re-solidification. It does not include grinding required by the *D1.5 Bridge Welding Code* or ASTM A6 to remove cutting, handling, or material anomalies.

**Experience:** Work activities accomplished in a specific test method under the direction of qualified supervision including performing the test methods and related activities but not including time spent in organized training programs.

**Fastener:** A mechanical device used to attach two or more items together, e.g., a bolt, nut, and washer.

**Faying Surfaces:** Contact surfaces within mechanically connected joints of steel structures.

**Flaking:** The detachment of pieces of the paint film itself either from its substrate or from paint previously applied. Flaking is generally preceded by cracking, checking or blistering and is the result of loss of adhesion usually due to stress-strain factors. ASTM D 722 is the standard test method for evaluating degree of flaking or exterior paints. Also referred to as scaling.

**Footcandle:** Unit of illuminance equal to one lumen per square foot.

**Gage Reading:** A single instrument reading.

**HICAMS Test Report:** Test report for material samples that are tested by the Department and provide and exhibit a sample status of "Meets Specs", "Does Not Meet Specs-Accepted" or "Rejected".

**Holiday:** Pinhole, skip, discontinuity, or void in a coating film that exposes the substrate.

**Immersion Service:** Exposure to continuous or intermittent submerged conditions.

**Inaccessible or Limited Access Areas:** Partially or completely enclosed surfaces, the majority of which are not visible without the use of special devices such as mirrors and not readily accessible for coating by routine methods.

**Inspection:** Phase of quality control which by means of examination, observation, or measurement determines the conformance to predetermined quality requirements.

**Lifting:** Softening and raising or wrinkling of a previous coat by the application of an additional coat. {Painting/Coatings Dictionary} Lifting often occurs because the solvents in the new coat are too strong for the previous coat.

**Lux (lx):** A unit of illumination equal to the direct illumination on a surface that is everywhere one meter from a uniform point source of one candle intensity or equal to one lumen per square meter.

**Micro-Cracking:** Cracks, visible only under magnification that develops in a coating at the time of application or during the drying process.

**Micrometer:** (1) One millionth of a meter, abbreviated as  $\mu\text{m}$ . Also sometimes called a micron. Coating thickness often is expressed in micrometers or microns; (2) An instrument used to measure profile depth (depth micrometer).

**Micron:** See Micrometer.

**Microsiemens:** A unit of electrical conductance equal to one millionth of a Siemens, abbreviated as  $\mu\text{S}$ .

**Mil:** One thousandth of an inch (0.001 inch, 25.4 micrometers). The thickness of a coating on a surface sometimes is expressed in mills and sometimes in micrometers or microns.

**Mill Scale:** The heavy, bluish oxide layer formed during hot fabrication or heat treatment of steel and other metals.

**Mist Coat:** A thin discontinuous spray coat applied prior to the application of a full thickness of coating. The

purpose of a mist coat is to penetrate and fill substrate or film porosity, thereby displacing air and minimizing gassing or bubbling in the finished coating system.

**Mud Cracking:** A coating defect resembling the irregular cracking of drying mud that typically arises during the curing of a relatively inflexible coating applied too thickly. Mud cracking is evident without magnification and usually penetrates the entire layer of the coating.

**Non-Conformance:** Deficiency in characteristic, documentation, or procedure that renders the quality of an item unacceptable or indeterminate.

**Overspray:** (1) Atomized paint particles that deflect from or miss the surface being sprayed; (2) Spray particles that are not wet enough to fuse when they reach the surface being sprayed. As a result, overspray may contaminate property beyond the surface being sprayed.

**Oxide:** Chemical reaction product, typically a metal, with oxygen

**Oxidant:** A substance containing oxygen that reacts with chemicals in air to produce a new substance.

**Paint:** A classification sometimes employed to distinguish pigmented drying oil coatings ("paints") from synthetic enamels and lacquers.

**Pinhole:** A holiday or discontinuity that extends entirely through a coating film, approximately the size of a pin, normally caused by solvent bubbling, moisture, or foreign materials.

**Pinholes:** Small pore-like flaws in a coating that extend entirely through the applied film and have the general appearance of pin pricks when viewed by reflected light.

**Pinholing:** The presence of a series of fine holes or voids in a film.

**Porosity:** (1) The ratio, usually expressed as a percentage of the volume of voids in a material to the total volume of the material including the voids [ACI]; (2) Small interconnected voids, such as in concrete, which allow fluids to penetrate an otherwise impervious material.

**Product Data Sheet (PDS):** Coating description document that includes surface preparation, application, curing, and other product-specific details required for good results.

**Psychrometer:** An instrument used to determine humidity and dew point. Sling psychrometers measure the wet and dry bulb temperature of air. With the aid of psychrometric tables, these measurements can be used to determine the dew point and relative humidity of the air.

**Psychrometric Tables:** US Weather Bureau Tables originally published by the US Department of Commerce, used to determine the relative humidity and dew point temperature from the dry and wet bulb readings obtained from the sling psychrometer.

**Qualified Product:** A coating product that has been approved based on testing to a Federal, State, or regional agency, or to a test protocol (e.g., AASHTO, NEPCOAT, NTPEP, or DOT protocol).

**Quality Assurance (Department):** Verifications of the conformance of materials and methods of application to the governing specifications to achieve the desired result.

**Raised Weld:** Fillet welds or groove welds that have not been ground flush.

**Relative Humidity:** The ratio of the actual pressure of existing water vapor to the maximum possible (saturation) pressure of water vapor in the atmosphere at the same temperature, expressed as a percentage.

**Runs:** Irregularities of a surface due to uneven flow, frequently due to application of a coat that is too heavy and not brushed out well. Also known as "sags" or "curtains." [MPDA]

**Rust:** The reddish material, primarily hydrated iron oxide, formed on iron or its alloys resulting from exposure to humid atmosphere or chemical attack. See "White Rust".

**Safety Data Sheet (SDS):** The SDS includes information such as the properties of each chemical; the physical, health, and environmental health hazards; protective measures; and safety precautions for handling, storing, and transporting the chemical.

**Sag or Sagging:** A non-uniform downward flow of a wet paint film that occurs between the times of application and setting, resulting in an uneven coating having a thick lower edge.

**Scaling:** Paint failure that causes a coating to fall off in flakes or chips. Scaling is the last stage of cracking. Moisture entering cracks in the paint film destroys its adhesive property and results in the flaking or scaling of the paint {PDCA}

**Shall:** A verb used to express the mandatory requirements of this program.

**Sharp Edge:** A corner on a steel section that ends in a point or edge and appears able to cut human flesh.

**Shims (Foil):** Strips of flat sheet, with the thickness stated or referenced in some form, which can be used to adjust a Type 2 coating thickness gage in the intended range of use over the surface of the representative substrate material.

**Should:** A verb used to express the desired requirements of this program.

**Soil:** Disfiguring foreign materials such as dirt, soot, or stain, other than microorganisms, deposited on or embedded in a dried film of applied coating material; also called *dirt*.

**Soilant:** A discoloring substance with a dispersed color component that is not in solution and therefore can cling to the surface of a coating without penetrating into the film. A soilant differs from a stain in that the colorant of a stain is in solution and therefore can penetrate into the film.

**Spalling:** The chipping or fragmenting of a surface or surface coating caused, for example, by differential thermal expansion or contraction. {MPDA}. Spalling of a concrete surface also may result from corrosion of rebar or other embedded steel.

**Spot Measurement:** The average of three or at least three gage readings made within a 4-cm (approximately [~]1.5- in) diameter circle.

**Stain:** (1) A penetrating composition that changes the color of a surface, usually transparent and leaving practically no surface film; (2) Discoloration, arising from foreign materials, that penetrates into the coating.

**Stripe Coat:** An additional coat of paint applied to the edges, raised welds, outside corners and areas difficult to coat by spray before or after a full coat is applied to the surface. The stripe coat is intended to ensure those areas receive the required dry film thickness (DFT) to resist corrosion.

**Substrate:** The underlying material or surface to which other material such as an ink, paint, coating, sealer or other treatment is applied.

**Surface Glare:** Reflections of artificial light that interfere with visual examination.

**Thinner:** The portion of a paint, varnish, lacquer, printing ink or related product that volatilizes during the drying process.

**Type 2 Electronic Gage:** Instruments that employ a measuring probe and the magnetic induction, Hall-effect or eddy current measurement principle in conjunction with electronic microprocessors to produce a coating thickness measurement. The gage probe must be placed directly on the surface (in a perpendicular position).

**Undercoating:** This term is used for electrodeposited coatings. A metallic coating layer between the basis metal or substrate and the topmost metallic coating. The thickness of an undercoating is usually greater than 0.8 micro inches. ASTM B605 is the Standard Specification for Electrodeposited Coatings of Tin-Nickel Alloy.

**Verification of Accuracy:** Obtaining measurements on coating thickness standards, comprised of at least one thickness value close to the expected coating thickness, prior to gage use for the purpose of determining the ability of the coating thickness gage to produce thickness results within the gage manufacturer's stated accuracy.

**Visible Coating Defects:** Imperfections that may be detected by examination without magnification. These include runs, sags, lifting, chipping, cracking, spalling, flaking, mud-cracking, pinholing, and checking.

**Void:** A small hole in a coating or on a surface of a coating.

**Weathering Steel:** High strength steel which forms a thin protective oxide film that does not require painting in many exposure locations. Common trade names are Corten or Mayar.

**Weld Spatter, Tight:** Beads of metal produced during the welding process with adequate thermal energy to adhere on metal in the weld area. The droplets retain their individual shape but have sufficient fusion to resist removal by hand scraping with a putty knife, per SSPC-SP 2.

**Wet Bulb Depression:** The difference between the dry bulb temperature (t) and the wet bulb temperature (tw).

**Wet Bulb Temperature:** The temperature recorded on the wet bulb thermometer of a psychrometer.

**Wet Bulb Thermometer:** The thermometer on a sling or other psychrometer whose bulb is covered with a wet cotton sock.

**White Rust:** White corrosion products (zinc hydroxide and zinc oxide) on zinc-coated articles. They form when the parts are stored so close together that condensed moisture is entrapped between them and the air circulation is inadequate to assist drying. Also called wet storage stain.

## REFERENCES

### **AASHTO: American Association of State Highway and Transportation Officials**

- AASHTO M 270, Standard Specification for Structural Steel Bridges
- AASHTO M 300, Standard Specification for Inorganic Zinc-Rich Primer
- AASHTO R 31, Standard Practice for Evaluation of Coating Systems with Zinc-Rich Primers
- AASHTO/NSBA S8.1-2014, SSPC PA Guide 13, Guide Specification for Application of Coating Systems with Zinc-Rich Primers to Steel Bridges

### **AMS: Aerospace Materials Specification-Standard 595A**

### **AISC: American Institute for Steel Construction**

- AISC 204-08 Certification Program for Bridge and Highway Metal Component Manufacturers
- AISC 420-10/SSPC-QP 3, Certification Standard for Shop Application of Complex Protective Coating Systems

### **ASME: American Society of Mechanical Engineers**

- ASME Section V, Article 9, Visual Examination

### **ASNT: American Society for Nondestructive Testing**

- Recommended Practice No. SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing

### **ASTM: American Society for Testing and Materials**

- ASTM A6, Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
- ASTM A252, Standard Specification for Welded and Seamless Steel Pipe Piles
- ASTM A328, Standard Specification for Steel Sheet Piling
- ASTM A690, Standard Specification for High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments
- ASTM C136, Test Method for Sieve Analysis of Fine and Coarse Aggregates
- ASTM D16, Standard Terminology for Paint, Related Coatings, Materials, and Applications
- ASTM D660, Standard Test for Evaluating Degree of Checking of Exterior Paints
- ASTM D661, Standard Test Method for Evaluating Degree of Cracking of Exterior Paints
- ASTM D722, Standard Test Method for Evaluating Degree of Flaking of Exterior Paints
- ASTM D1079, Standard Terminology Relating to Roofing and Waterproofing
- ASTM D1356, Standard Terminology Relating to Sampling and Analysis of Atmospheres
- ASTM D1640, Standard Test Method for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature
- ASTM D3170, Standard Test Method for Chipping Resistance of Coatings
- ASTM D3335, Standard Test Method for Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy
- ASTM D3359, Standard Methods for Measuring Adhesion by Tape Test
- ASTM D3363, Standard Test Method for Film Hardness by Pencil Test
- ASTM D3450, Standard Test Method for Washability Properties of Interior Architectural Coatings
- ASTM D4138, Standard Test Method for Measuring of Dry Paint Thickness of Protective Coating Systems by Destructive Means
- ASTM D4285, Standard Test Method for Indicating Oil or Water in Compressed Air
- ASTM D4414, Standard Practice for Measurement of Wet Film Thickness by Notch Gages
- ASTM D4417, Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
- ASTM D4538, Standard Terminology Relating to Protective Coating and Lining Work for Power Generation Facilities

- ASTM D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
- ASTM D4752, Standard Test Method for Measuring MEK Resistance of Ethyl Silicate Zinc-Rich Primers by Solvent Rub
- ASTM D4940, Standard Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blast Abrasive
- 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 D7127, Standard Test Method for Measurement of Surface Roughness of Abrasive Blast Cleaned Metal Surfaces Using a Portable Stylus Instrument
- ASTM D7393, Standard Practice for Indicating Oil in Abrasives
- ASTM E41, Standard Terminology Relating to Conditioning
- ASTM E77, Standard Test Method for Inspection and Verification of Thermometers
- ASTM E284, Standard Terminology of Appearance
- ASTM E337, Standard Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures)
- ASTM F22, Standard Test Method for Hydrophobic Surface Films by the Water-Break Test
- ASTM F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 KSI (830 MPa) and 150 KSI (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions

**NACE: National Association of Corrosion Engineers**

- NACE Standard SP0178 (latest edition), Standard Recommended Practice: Fabrication Details, Surface Finish Requirements, and Proper Design Considerations for Tanks and Vessels to Be Lined for Immersion Service
- NACE SP0508-2010, Methods of Validating Equivalence to ISO 8502-9 on Measurement of the Levels of Soluble Salts

**NCDOT: North Carolina Department of Transportation**

- NCDOT Standard Specifications for Roads and Structures
- NCDOT Roadway Standard Drawings
- NCDOT Construction Manual

**SSPC: The Society for Protective Coatings**

- SSPC-AB 1, Mineral and Slag Abrasives
- SSPC-AB 2, Cleanliness of Recycled Ferrous Metallic Abrasives
- SSPC-AB 3, Ferrous Metallic Abrasive
- SSPC-AB 4, Recyclable Encapsulated Abrasive Media (in a Compressible Cellular Matrix)
- SSPC-Guide 6, Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations
- SSPC-Guide 13, Guide for the Identification and Use of Industrial Coating Material in Computerized Product Databases
- SSPC-Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates
- SSPC-PA 1, Shop, Field, and Maintenance Painting of Steel
- SSPC-PA 2, Procedure for Determining Conformance to Dry Coating Thickness Requirements
- SSPC-PA 17, Procedure for Determining Conformance to Steel Profile/Surface Roughness/Peak Count Requirements
- SSPC-Paint 20, Zinc-Rich Coating, (Type I—Inorganic, and Type II—Organic)
- SSPC-PS 12.00, Guide to Zinc-Rich Coating Systems
- 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 10/NACE No. 2, Near-White Metal Blast Cleaning
- SSPC-SP 11, Power Tool Cleaning to Bare Metal
- SSPC-SP 15, Commercial Grade Power Tool Cleaning
- SSPC-SP COM, Surface Preparation and Abrasives Commentary, SSPC Painting Manual, Volume 2, "Systems and Specifications"
- SSPC Technology Guide 15, Field Methods for Extraction and Analysis of Soluble Salts on Steel and Other Nonporous Substrates
- SSPC-VIS 1, Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning
- SSPC-VIS 3, Guide and Reference Photographs for Steel Surfaces Prepared by Power and Hand Tool Cleaning
- SSPC Protective Coating Coatings Glossary, Acronyms and Terms Related to Coating Industrial Steel and Concrete Structures as well as Failure Analysis and Regulations

### **RCSC: Research Council on Structural Connections**

- Specification for Structural Joints Using High-Strength Bolts

### **Related Reference Documents**

- Applicable Ordinances and Regulations
- ASTM STP500 Paint Testing Manual, Physical and Chemical Examination of Paints, Varnishes, Lacquers, and Colors
- Equipment and Coating Manufacturer's Published Instructions, Product Data Sheets and Safety Data Sheets
- Federation of Societies for Coating Technology, Coatings Encyclopedic Dictionary
- Federation of Societies for Coatings Technology, Painting/Coatings Dictionary
- Federation of Societies for Coatings Technology, Pictorial Standards of Coating Defects
- Good Painting Practice—SSPC Painting Manual, Volume 1
- Masters Painters and Decorators Association
- Master Painters Institute
- NSRP Report 0511, User's Guide to Selection of Blasting Abrasives, National Shipbuilding Research Program Final Report Project 3-95-7 (April 1998) Painting Contractors Association
- SSPC-Guide 12, Guide for Illumination of Industrial Painting Projects
- SSPC-Guide 16, Guide to Specifying and Selecting Dust Collectors
- SSPC-PA Guide 11, Guide to Protection of Edges, Crevices, and Irregular Surfaces

## **GENERAL INFORMATION**

Materials shall be coated in accordance with this program, the Contract Special Provisions, the latest edition of the current NCDOT Standard Specifications, and the manufacturer's recommendations; of these the more stringent shall apply. Materials not meeting these requirements will be considered defective. The Engineer may reject all such materials, whether installed or not. Upon rejection remove non-conforming material from the site of the work or tag such material with the appropriate "HOLD" tag or equivalent as identified in the Shop coatings facility Quality Control Manual until a corrective action plan has been submitted, approved and ready to implement. Nothing in this program, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

The following are minimum requirements for all quality control (QC) personnel.

- INSPECTION PERSONNEL QUALIFICATION

All quality control (QC) personnel shall be separated from production functions. All quality control (QC) personnel are subject to review and acceptance of the Engineer. The minimum certifications required are as follows:

- NACE CIP Level I or SSPC BCI Level I for Shop applications.
- Near-Vision Acuity: The examination shall ensure natural or corrected near-distance acuity in at least one eye such that the applicant is capable of reading a minimum of Jaeger Number 2 or equivalent type and size letter at the distance designated on the chart but not less than twelve (12) inches on a standard Jaeger test chart. (Required annually)
- Color Contrast Differentiation: The examination shall demonstrate the capability of distinguishing and differentiating contrast among colors or shades of gray used in the method as determined by the Shop coating facility. (Required annually)

## 1.0 PRE-QUALIFICATION

1.1 The minimum qualifications for a Shop coating facility to perform work for the Department are as follows:

1.1.1 Shop facilities that are currently certified and in good standing with the American Institute of Steel Construction (AISC)/Sophisticated Paint Endorsement (SPE) and/or the Society of Protective Coatings (SSPC) Qualification Procedure Three (QP-3).

1.2 Shop facilities shall employ or possess a sub-contract mechanism to provide a NACE CIP Level III to periodically monitor QC functions.

1.3 These personnel shall be responsible for QC inspection and examination activities and upon completion, review and sign off on the final turnover package to be submitted for the project.

1.4 Each Shop coating facility (shop) shall be pre-qualified before it is allowed to apply any coating system (regardless of square footage) for NCDOT projects. A list of approved facilities is provided under Facility Type: "Structural Steel Shop Coating Facility" at the following link:  
<https://apps.ncdot.gov/vendor/approvedproducts/Producer.aspx>

1.5 The minimum requirements for shop prequalification are as follows:

- Enclosed Shop: As per modified AISC/SSPC, an enclosed shop is a permanent facility or building (four continuous walls or partitions to grade or floor with a roof). The purpose of an enclosed shop requirement is to control the environmental conditions prior to coating application, during the coating application, and to allow sufficient curing times to handle and prevent contamination of the shop applied coating system.
- Compliance with AISC and/or SSPC certification programs identified above.
- 18 months of previous coating application experience on similar structures.
- Abrasives: Name of product, Manufacturer/Supplier, mesh size, cleanliness report, certification of conformance to all requirements of SSPC AB1 and/or SSPC AB 3 as supplied by the abrasive supplier. Testing documentation of the recycled work mix as required by SSPC AB-2 prior to first use.
- Blasting Equipment: Type and name of the Manufacturer/Supplier.
- Coating Material: Name of product and Manufacturer/Supplier.

- Review and approval of application equipment and coating material information. Minimum equipment shall be a conventional and/or airless spray system with a built-in mechanical agitator for inorganic and/or organic zinc application with recommended tip sizes and air pressure settings.
- Review of the Quality Control plan to include QC personnel responsible for oversight, inspection activities, surface preparation, coating application procedures, and coating repair procedures.
- Review and approval of material numbering/labeling/identification plan.

1.6 These requirements if more stringent, shall apply.

## 2.0 REVOCATION OF QUALIFIED STATUS

- 2.1 Qualification of a Shop coating facility may be revoked for a time as determined by the Engineer. The Engineer is defined in Article 101-3 of the *Standard Specifications* for Roads and Structures. Criteria for removal are as follows:
- 2.1.1 Critical and major deficiencies as defined by the Engineer.
  - 2.1.2 Failure to respond to the Engineer's request for information.
  - 2.1.3 Failure to correct continued non-conforming quality. A repetitive non-conforming item requires a corrective action plan to be submitted and approved by the Engineer, implemented and monitored by the Shop coating facility.
  - 2.1.4 Failure to maintain the minimum qualifications for a Shop coating facility outlined in the Pre-Qualification section of this program.
  - 2.1.5 Failure to repair coating layers that have been applied and approved by the Shop coating facility that exhibit any visible rust that cannot be removed by pressure washing.

## 3.0 NOTIFICATION OF WORK

- 3.1. Prior to starting work, in-state Shop coating facilities shall provide a minimum of three (3) working days' notice and out-of-state Shop coating facilities shall provide a minimum of eight (8) working days' notice by submitting a Notification of Beginning Work Form ([Attachment 1](#)). An electronic version can be found downloaded from the Materials and Tests website: <https://connect.ncdot.gov/resources/Materials/Pages/Materials-Manual-by-Material.aspx?Order=MM-05-02>
- 3.2. When submitting the form ([Attachment 1](#)), the facility shall include work schedule, days per week, hours per day and number of shifts. Typical working hours are considered Monday through Friday (8am- 5pm).
- 3.3. If the Coater and/or Fabricator are at the same location, no additional notification is required.
- 3.4. If the Shop coating facility does not perform scheduled work for a period exceeding three (3) consecutive days, additional notification of work as identified above shall be submitted. Any work performed without proper notification as identified above will be performed at the Shop coating facility's risk.
- 3.5. At the Shop coating facility's option, reimbursement of the cost of the Department's quality assurance inspection to facilitate varying work schedules may be requested. This shall be submitted to the Engineer in writing.

## 4.0 PRE-JOB MEETING

4.1 The Department may require a pre-job meeting for specific applications as determined by the Engineer.

## 5.0 SAFETY

5.1 Shop coating facilities may be involved in the use of hazardous materials, operations, and equipment. This program does not address all of the potential safety concerns associated with their use. It is the responsibility of the Shop coating facility to establish appropriate safety and health requirements and determine any regulatory requirements or limitations prior to use.

5.2 Personnel involved in the inspection and/or oversight of any coating application should work directly with the Shop coating facility's safety personnel to ensure proper safety protocol is being followed.

## 6.0 STORAGE AND HANDLING

6.1 For all components coated under this program, the Shop coating facility shall take all necessary precautions to prevent any contamination and/or damage during handling, storage and transportation which include storing in the open air at any time during the coating process (surface preparation through curing of top coat). Storage shall be in accordance with Section 442 of the *Standard Specifications*.

## 7.0 PAINT MATERIALS

7.1 Unless otherwise specified all paint material shall be manufactured and tested in accordance with the following Articles of the *Standard Specifications*: Inorganic Zinc- Article 1080-5, Coal Tar Epoxy- Article 1080-6, Organic Zinc- Article 1080-7 and Waterborne Paints- Article 1080-9.

7.2 Use paint materials provided by Coating Manufacturers that are listed on the NCDOT Approved Products Listing. A complete list of approved products may be found on the NCDOT Approved Products Listing at: <https://apps.dot.state.nc.us/vendor/approvedproducts/>. Under Product Group, select "Paints (1080)".

7.3 Coatings applied to faying surfaces that incorporate slip critical or pre-tensioned joint design shall meet the slip coefficient required by AASHTO LRFD Bridge Design Specifications and Research Council on Structural Connections (RCSC) as applicable.

7.4 All material coatings applied shall be from the same manufacturer. Prior to the application of any coating including a bolted joint designed to meet slip critical or pre-tensioned as defined by the Research Council on Structural Connections (RCSC), the Shop coating facility shall provide the Engineer the following:

- Copy of the manufacturers slip coefficient test and essential variables
- Product data sheet
- Recommendations for product thinning
- Safety Data Sheet (SDS) (formerly MSDS)
- Manufacturer's certification(s)
- NCDOT HICAMS test report for each type, color and/or batch of coating used on the project.

## 8.0 PAINT SYSTEMS

8.1 There are currently six (6) paint systems that are used to protect steel structures. A summary of the paint systems is as follows:

- Paint Systems 1 and 2 are specified for non-weathering structural steel exposed to atmospheric and/or rural atmospheres.
- Paint Systems 3 and 4 are specified for weathering and/or non-weathering structural steel exposed to marine environments.
- Paint Systems 5 and 6 are specified for weathering structural steel that consists of applying all primer and finish paints at the ends of beams or girders within a distance of 1.5 times the depth of the beam or girder at the bearing except as otherwise specified.

8.2 Paint Systems 1 and 2 are specified for non-weathering structural steel exposed to atmospheric and/or rural atmospheres. Unless otherwise specified, use the Aerospace Materials Specification (AMS) Standard 595A Color #30045 for the brown acrylic and #26622 for the gray acrylic. As an option, acrylic top coats may be applied in the field. Apply the paint system required by the plans at the film thickness indicated below and in sequence listed.

<b>SYSTEM 1, INORGANIC ZINC (IOZ) PRIMER AND ACRYLIC TOP COAT</b>				
<b>Coating Layer</b>	<b>Minimum Test Requirements*</b>	<b>Material</b>	<b>Mils Dry/Wet Film Thickness**</b>	
			<b>Min.</b>	<b>Max.</b>
Primer	MEK Rub Test Adhesion Pull Off Test	IOZ (See Article 1080-5)	3.0 DFT	5.0 DFT
Intermediate	Thumb Test	Brown (See Article 1080-9)	2.0 DFT	4.0 DFT
Stripe	Thumb Test	White (See Article 1080-9)	4.0 WFT	7.0 WFT
Topcoat	Thumb Test X-Cut Tape Test	Gray (See Article 1080-9)	3.0 DFT	5.0 DFT
<b>Total</b>			<b>8.0 DFT</b>	<b>14.0 DFT</b>

\*See [Table 1](#).

\*\* **Manufacturer's recommendation shall be reviewed and the more stringent shall apply.**

<b>SYSTEM 2, INORGANIC ZINC (IOZ) PRIMER AND High Build (HB) ACRYLIC TOP COAT</b>				
<b>Coating Layer</b>	<b>Minimum Test Requirements*</b>	<b>Material</b>	<b>Mils Dry/Wet Film Thickness**</b>	
			<b>Min.</b>	<b>Max.</b>
Primer	MEK Rub Test Adhesion Pull Off Test	IOZ (See Article 1080-5)	3.0 DFT	5.0 DFT
Stripe	Thumb Test	White (See Article 1080-9)	4.0 WFT	7.0 WFT
Topcoat	Thumb Test X-Cut Tape Test	Gray (See Article 1080-9)	5.0 DFT	9.0 DFT
<b>Total</b>			<b>8.0 DFT</b>	<b>14.0 DFT</b>

\*See [Table 1](#).

\*\* **Manufacturer's recommendation shall be reviewed and the more stringent shall apply.**

8.3 Paint Systems 3 and 4 are specified for weathering and/or non-weathering structural steel exposed to marine environments. For Paint System 3 use red (color as supplied by manufacturer) for the intermediate layer and black (color as supplied by manufacturer). Unless otherwise specified for Paint System 3 or 4 use contrasting colors for the intermediate and topcoat. Apply the paint system required by the plans at the film thickness indicated below and in sequence listed.

<b>SYSTEM 3, INORGANIC ZINC (IOZ) PRIMER AND COAL TAR EPOXY TOP COAT</b>				
<b>Coating Layer</b>	<b>Minimum Test Requirements*</b>	<b>Material</b>	<b>Mils Dry/Wet Film Thickness**</b>	
			<b>Min.</b>	<b>Max.</b>
Primer	MEK Rub Test Adhesion Pull Off Test	IOZ (See Article 1080-5)	3.0 DFT	5.0 DFT
Intermediate	<b>Note A</b>	Red (See Article 1080-6)	8.0 DFT	12.0 DFT
Topcoat	Adhesion Pull Test	Black (See Article 1080-6)	8.0 DFT	12.0 DFT
<b>Total</b>			<b>19.0 DFT</b>	<b>N/A</b>

\*See [Table 1](#).

\*\* **Manufacturer's recommendation shall be reviewed and the more stringent shall apply.**

**Note A. Based on the manufactures recoat time dry film thickness readings may not be obtained.**

<b>SYSTEM 4, INORGANIC ZINC (IOZ) PRIMER AND ALTERNATE TOP COAT</b>				
<b>Coating Layer</b>	<b>Minimum Test Requirements*</b>	<b>Material</b>	<b>Mils Dry/Wet Film Thickness**</b>	
			<b>Min.</b>	<b>Max.</b>
Primer	MEK Rub Test Adhesion Pull Off Test	IOZ (See Article 1080-5)	3.0 DFT	5.0 DFT
Intermediate	Note A	NORSOK M501, No. 7***	8.0 DFT	12.0 DFT
Topcoat	Adhesion Pull Off Test	NORSOK M501, No. 7***	8.0 DFT	12.0 DFT
<b>Total</b>			<b>19.0 DFT</b>	<b>N/A</b>

\* See [Table 1](#).

\*\* **Manufacturer's recommendation shall be reviewed and the more stringent shall apply.**

\*\*\***NORSOK Standard M-501, Coating System No. 7 approved coating system or approved NEPCOAT coating. Intermediate and top coats must be contrasting colors.**

**Note A. Based on the manufactures recoat time dry film thickness readings may not be obtained.**

8.4 Paint Systems 5 and 6 are specified for weathering structural steel that consists of applying all primer and finish paints at the ends of beams or girders within a distance of 1.5 times the depth of the beam or girder at the bearing except as otherwise specified. Unless otherwise specified use the Aerospace Materials Specification (AMS) Standard 595A Color #30045 or #20045 for the brown acrylic. Apply the paint system required by the plans at the film thickness indicated below and in sequence listed.

<b>SYSTEM 5, ORGANIC ZINC (OZ) PRIMER AND ACRYLIC TOP COAT FOR WEATHERING STEEL</b>				
<b>Coat</b>	<b>Minimum Test Requirements*</b>	<b>Material</b>	<b>Mils Dry/Wet Film Thickness**</b>	
			<b>Min.</b>	<b>Max.</b>
Primer	Pencil Hardness Test Adhesion Pull Off Test	OZ (See Article 1080-7)	3.0 DFT	5.0 DFT
Intermediate	Thumb Test	Brown (See Article 1080-9)	2.0 DFT	4.0 DFT
Stripe	Thumb Test	White (See Article 1080-9)	4.0 WFT	7.0 WFT
Topcoat	Thumb Test X-Cut Tape Test	Brown (See Article 1080-9)	3.0 DFT	5.0 DFT
<b>Total</b>			<b>8.0 DFT</b>	<b>14.0 DFT</b>

\*See [Table 1](#).

\*\* **Manufacturer's recommendation shall be reviewed and the more stringent shall apply.**

<b>SYSTEM 6, ORGANIC ZINC (OZ) PRIMER AND HB ACRYLIC TOP COAT FOR WEATHERING STEEL</b>				
<b>Coat</b>	<b>Minimum Test Requirements*</b>	<b>Material</b>	<b>Mils Dry/Wet Film Thickness**</b>	
			<b>Min.</b>	<b>Max.</b>
Primer	Pencil Hardness Test Adhesion Pull Off Test	OZ (See Article 1080-7)	3.0 DFT	5.0 DFT
Stripe	Thumb Test	White (See Article 1080-9)	4.0 WFT	7.0 WFT
Topcoat	Thumb Test X-Cut Tape Test	Brown (See Article 1080-9)	5.0 DFT	9.0 DFT
<b>Total</b>			<b>8.0 DFT</b>	<b>14.0 DFT</b>

\*See [Table 1](#).

\*\* **Manufacturer's recommendation shall be reviewed and the more stringent shall apply.**

## 9.0 PAINTING STEEL STRUCTURES

### 9.1 General

#### 9.1.1 Do not paint the following surfaces:

- Bearing assemblies, plates and other galvanized or metallized parts.
- Areas where field welding is to be performed.
- Outside surfaces of splice plates (Systems 5 and 6 only).
- Plate surfaces contacting elastomeric bearing pads.
- Contact surfaces with block-outs for bolted connections on curved girder bridges and beam and girder splices (Systems 5 and 6 only).
- In the areas of block-outs, extend the finish paint no closer than 2 inches nor more than 3 inches from the edges of contact surfaces in bolted connections. Ensure that the primer paint is clearly visible around these areas when the structural steel is assembled. The same offset dimensions are required for finish paint at field welds, measured from the proposed location of the field weld.

9.1.2 Areas where paint is not required, overspray is permitted on shear connectors and the top surface of the top flange.

9.1.3 Clean and paint stiffener clips and other obstructed areas to prevent rust. Such areas are those that contain enclosed surfaces, the majority of which are not visible.

9.1.4 Apply a stripe coat by brush or roller on all bolts, edges, corners and raised welds.

9.1.5 Provide a repair procedure for all damage and defects for approval before painting.

9.1.6 Do not load material for shipment until at least 24 hours after applying the paint and the paint is thoroughly cured.

## 10.0 SURFACE PREPARATION

### 10.1 Special Attention

10.1.1 The Department shall be given the opportunity to witness all phases of work necessary in preparing the surfaces to be coated.

10.1.2 Prepare steel surfaces in the shop in accordance with Article 442-7 of the *Standard Specifications*. Check abrasives daily for contaminants or as otherwise directed by the Engineer. Verify that abrasive material meets the cleanliness requirements of SSPC AB-1, SSPC AB-2 and/or SSPC AB-3 depending on the abrasive material used. The following items are required as a part of preparation and cleaning and shall be done before application of the prime coat:

10.1.2.1 Corner Condition: Bevel corners to an approximate 1/16" chamfer if the included angle is less than 90 degrees.

10.1.2.2 Surface Irregularities: Remove slivers, hackles, tears and projection of blast cleaned steel. Restore the profile in areas larger than one square foot.

- 10.1.2.3 Weld Spatter: Remove excessive and loose weld spatter. Tightly adherent weld spatter not protruding above the final coat is permitted.
- 10.1.2.4 Bolts: Galvanized (mechanically or hot dip) fastener assemblies shall be prepared in accordance with the requirements of this program, the National Steel Bridge Alliance (NSBA) S8.1 (latest edition) and the coating manufacturer's recommendations of which the more stringent shall apply. At a minimum, the preparation process of galvanized fastener assemblies shall incorporate solvent cleaning as outlined below.

### 10.1.3 **Fabrication shall be complete before surface preparation begins.**

- 10.1.3.1 Structural members utilizing welded construction shall incorporate seal welding of these connections for any design that may be prone to staining, oxidation and/or rust bleed out after the completion of the shop coating process.
- 10.1.3.2 The Shop coating facility shall submit a plan to the Engineer prior to beginning work for structural members that are comprised of complex geometries and/or members (sheet piles) that may require additional assembly after the coating application process is complete to address continued staining, oxidation and/or rust bleed out.
- 10.1.2.3 If the material is being transported in adverse weather conditions, the Shop coating facility shall notify the Department. The Engineer may require the Shop coating facility to test for the presence of chlorides, and, if necessary, clean the material as directed by the Engineer.

## 10.2 Solvent Cleaning

- 10.2.1 Prior to blast cleaning, remove all substances from areas to be painted that would be deleterious to the adhesion of coating in accordance to SSPC SP 1 and to the satisfaction of the Engineer. This includes but is not limited to oil, grease, cutting oils, couplant, grease-based marking devices, anti-spatter material and other visible contaminants. For fastener assemblies where blasting operations are employed for the removal of lubricant, QC shall verify the specified surface cleanliness has been achieved.
- 10.2.2 QC shall document the type of solvent used and verify their removal in accordance with ASTM F22 or other approved method. If air powered tools are used after final abrasive blast cleaning, QC shall inspect and verify all prepared surfaces are free from oil prior to applying any coating layer.

## 10.3 Equipment

- 10.3.1 Compressed air utilized in the cleaning process shall be free of water and oil. Adequate separators and traps shall be provided, installed in the coolest part of the system.
- 10.3.2 For manually-operated blast equipment, the presence of oil and water shall be determined in accordance with ASTM D-4285 at least one (1) time per eight (8) hour shift and following every compressor start-up.

## 10.4 Blasting Operations

- 10.4.1 Unless otherwise specified surface preparation shall be in accordance with SSPC SP-10 (Near White Metal Blast) for all Department coating systems. Use blasting equipment in accordance with the manufacturer's recommendations.
- 10.4.2 The use of power tools is acceptable for the removal of mill scale on weathering steel areas outside of the coated area provided the uncoated area exhibits a surface finish that weathers uniformly as determined by the Engineer.
- 10.4.3 Prior to the application of any coating layer, material shall be free from staining. This is defined as an area of a surface which, when compared to adjacent areas, has an equal surface profile but is discolored (straw colored) with a material having no apparent volume. The discoloration cannot be removed by methods commonly used to remove dust but can be removed by more thorough abrasive blasting. (SSPC Protective Coatings Glossary)
- 10.4.4 Perform surface inspection once all blast abrasive and dust are removed from surface to be coated. Examine the blast cleaned surface for any traces of oil, grease or smudges deposited in the cleaning operations. If present, remove them in accordance with SSPC SP-1 or an approved method.
- 10.4.5 QC shall record ambient conditions at the time of final blast cleaning and prior to coating application. Do not perform blasting operations when the temperature of the steel surface is less than 5 degrees above the dew point of the surrounding air or the relative humidity of the air is greater than 85%.
- 10.4.6 If the ambient conditions outlined above exceed the maximum specified and/or the dew point temperatures cannot be maintained, the surface cleanliness shall be verified by QC. If the surface cleanliness is not in conformance with the contract documents, non-conforming areas shall again be abrasive blast cleaned.
- 10.4.7 Utilize Table 5.1 of NSBA Guide Specification for Application of Coating Systems with Zinc-Rich Primers to Steel Bridges for all fastener assemblies. For mechanically or hot dipped galvanized assemblies, verify complete removal of colored lubricant on exposed surfaces prior to coating application.

## 10.5 Surface Profile

- 10.5.1 The surface profile shall be verified and documented in accordance with ASTM D-4417 and impart a 1.0 to 3.0 mil minimum angular profile. The average of readings obtained at each location ("location average") shall be within the specified profile range.
- 10.5.2 Weld or base metal discontinuities that do not meet the requirements of ASTM A6 and/or contract requirements that are discovered after surface preparation shall be repaired in accordance with ASTM A6. Any deposition of weld metal required to correct surface imperfections described in ASTM A6 and/or that does not meet the requirements of the contract shall be subject to approval by the Engineer. If after repair, the surface cleanliness is not in conformance with the Contract Documents, non-conforming areas shall again be abrasive blast cleaned.

## 11.0 SPECIFIC COATING APPLICATION

11.1 Apply all coatings in accordance with the contract requirements, SSPC PA-1 and the coating manufacturer's instructions. Follow the more restrictive requirements. Harsh environments may necessitate re-cleaning during or between paint applications.

### 11.2 Dust Assessment

11.2.1 Prior to coating, care shall be taken to ensure the product does not have or is exposed to airborne dust and/or contaminants that will have an adverse effect on the end use of the product.

### 11.3 Coating Application Process

11.3.1 QC shall verify and document ambient conditions prior to all coating applications or when environmental conditions change. Ambient conditions not meeting the requirements specified in this program shall be unacceptable to the Engineer. The minimum temperature of the steel surfaces shall not be less than 5 degrees above the dew point of the surrounding air and the relative humidity of the air shall not be greater than 85%. For zinc applications, the manufacturer's recommendations for relative humidity may be adopted.

11.3.2 All coating application specified in this program shall be performed as outlined in Article 442-9 of the *Standard Specifications*. The material to be coated shall be positioned in such a manner that the finished product when viewed by visual inspection reflects continuity in each coating layer. Continuity for the coating application process is to include surface texture applicable to overlapping and crossing passes to eliminate thin spots, holidays and stay within the coating thickness specification.

11.3.3 The Applicator shall pay particular attention to the coating application on bent radius, bolts, edges and welds. The Applicator shall apply the specified coating to these areas maintaining a work angle perpendicular to the bend radius, bolts, edges or welds throughout the application process ensuring 100% coverage of these critical areas. Members with complex geometries shall be evaluated by the Shop coating facility for proper application and coverage.

11.3.4 The Applicator shall apply a technique that will provide specified overlap and minimize a gross deviation of work angle that may result in unacceptable surface texture, excessive overspray, loss of coating adhesion, holidays, bare areas, pinholes and/or detrimental discontinuities in the coating layers.

11.3.5 If blistering or a degraded coating appears at any time during the coating application process, stop work and notify QC for direction.

11.3.6 Use enclosures that control atmospheric conditions inside within limits suitable for coating and until the coating layer has cured in accordance with the manufacturer's recommendations sufficiently to handle, re-coat, obtain DFT readings and/or withstand environmental conditions that may result in the coating layer being contaminated.

11.3.7 Upon successful completion of the coating application process and prior to successive coating applications, the dry film thickness (DFT) shall meet the requirements of the specified paint system.

## 12.0 INSPECTION

### 12.1 QC Personnel

12.1.1 QC personnel must have immediate access (at the Shop coating facility) to all specifications and/or contract and referenced written and/or visual standards (e.g., SSPC, ASTM standards).

### 12.2 Inspection Equipment

12.2.1 Unless more stringent requirements are specified by the manufacturer or stated in the Shop coatings facility's Quality Manual, calibration verification of instruments used for inspection is performed by the equipment manufacturer annually. The Shop coating facility maintains calibration records and certificates in the office for all instruments that require formal calibration. Calibration records shall be available for instruments being used by QC personnel on site.

12.2.2 At a minimum, QC personnel shall use calibrated instruments as identified in their QC Manual and the equipment manufacturer's recommendations as provided to the Department in the Prequalification section of this program. They shall conduct the required quality control tests in accordance with these requirements and report the minimum information required by the appropriate ASTM test methods and these provisions.

12.2.3 See [Table 1](#) for the required inspections. The minimum test equipment to be utilized when performing inspections is listed below:

- Visible Light Meter
- Abrasive Cleanliness
- Conductivity Meter, ASTM D-4940
- Indicating Oil in Abrasives, ASTM D-7393
- Sling Psychrometer, Bulb Type, ASTM E-337, Method B
- U.S. Department of Commerce Psychrometric Tables
- Surface Temperature Thermometer
- SSPC VIS 1 and SSPC VIS 3 Standards
- Field Measurement of Surface Profile of Blast Cleaned Steel, ASTM D-4417, Method C
- Surface Condition Standards, SSPC VIS-1 and VIS-3
- Surface Contamination Analysis Kit or (Chloride Level Test Kit) SSPC Technology Guide 15 and/or NACE SP0508
- Wet Film Thickness Gage, ASTM D-4414
- Dry Film Thickness Gage, Type 2, ASTM D-7091 and/or SSPC-PA2
- MEK Rub Test, ASTM D-4752
- Film Hardness by Pencil Test, ASTM D-3363
- Adhesion Pull Test, ASTM D-4541 (Annex A3 and/or A4 for curved surfaces)
- Drying, Curing, or Film Formation of Organic Coatings, ASTM D-1640
- Measuring Adhesion by Tape Test, ASTM D-3359, Method A

12.2.4 At the discretion of the Shop coating facility, electronic or other digital equipment may be utilized provided it has been pre-approved by the Department.

12.2.5 Utilize tables Table 6.1, 6.2 and 6.3 of the NSBA "Guide Specification for Application of Coating Systems with Zinc-Rich Primers to Steel Bridges" for additional QC documentation and retention.

### 12.3 Reporting

- 12.3.1 Quality Control shall provide coating inspection reports to the Department in accordance with the requirements of NCDOT *Standard Specifications* Section 442 and the requirements of this program.
- 12.3.2 QC shall conduct the required quality control tests as outlined in Table 1, in accordance with the requirements of this program in accordance, and report the minimum information required by the appropriate ASTM test methods and these provisions.
- 12.3.3 QC is required to record and maintain inspections that are specified by the contract and in accordance with the current *Standard Specifications*, ensuring that they are signed by the QC inspector who performed the inspection. The Shop coating facilities NACE CIP Level III shall periodically review and sign QC personnel inspection reports. These records shall be available at the shop for review by Quality Assurance.
- 12.3.4 At a minimum, the quality control forms shall be on company letterhead with logo that provides a daily inspection report form equivalent to the information required on M&T-611 (Attachment 3). This documentation shall be submitted to the Quality Assurance representative at the end of each work week or as directed. Digital versions of these forms can be found on the NCDOT Materials and Tests webpage: <https://connect.ncdot.gov/resources/Materials/Pages/Materials-Manual-by-Material.aspx?Order=MM-05-02>

### 12.4 Visual Inspection

- 12.4.1 Visual examination using line of sight vision of surface preparation or coating inspection shall be done at an angle not less than 30 degrees and at a distance of no more than 24 inches. Ambient lighting as measured at the inspection surface shall not be less than 50-foot candles.
- 12.4.2 All blast cleaned surfaces shall meet SSPC SP-10 (Near White Metal Blast Cleaning). When viewed by direct visual observation and without magnification, the blasted surface shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter.
- 12.4.3 All coating layers, when viewed by direct visual observation shall not exhibit any dry spray/overspray, mud cracking, drips, sags, runs, checking, crazing, holidays (voids), pinholes, delamination (adhesive and/or cohesive), gross porosity, voids in any coating film that expose the substrate or previously applied coating layer or detrimental discontinuities as determined by the Engineer.
- 12.4.4 All final blasting operations for weathering steel members shall provide a surface finish that weathers uniformly as determined by the Engineer.
- 12.4.5 Any surface contamination of the end-product as a result of improper storage and/or protection as defined by the Engineer shall be removed by the Shop coating facility prior to final acceptance by the Department.

## 12.5 Ambient Conditions

12.5.1 Ambient conditions shall be obtained prior to final abrasive blast cleaning, prior to each coating/coating layer application and/or every 4 hours as conditions change. Ambient conditions shall be obtained and shall include air temperature (wet bulb & dry bulb), relative humidity, dew point, and steel surface temperature. The U.S. Department of Commerce Psychrometric Tables in conjunction with ASTM E337 Method B shall be referenced for obtaining and documenting appropriate data.

12.5.2 The inspection frequency for obtaining ambient conditions are found in Table 1.

## 12.6 Abrasive Properties

12.6.1 Abrasive material shall meet the following requirements:

- SSPC AB-1 Mineral and Slag Abrasives (New and recycled mineral and slag abrasives)
- SSPC AB-2 Cleanliness of Recycled Ferrous Metallic Abrasives (Recycled abrasives prior to first use and thereafter)
- SSPC AB-3 Ferrous Metallic Abrasive (New abrasive)

12.6.2 **Note:** The essential variables of the equipment manufacturer's recommendations as it relates to blast pattern, abrasive work mix and abrasive flow (amps) should be considered when applying the standards above.

## 12.7 Surface Cleanliness

12.7.1 Visual inspection as outlined above shall be utilized to verify all surfaces to be coated meet the requirements of SSPC SP-10 (Near White Metal Blast Cleaning).

## 12.8 Surface Profile

12.8.1 Obtain a 1.0 to 3.0 mil minimum angular profile. In order to obtain a consistent angular profile, it is imperative that the abrasive blast media be tested in accordance with SSPC AB-1, SSPC AB-2 and/or SSPC AB-3 as applicable. The abrasive blast media inspections are required to be performed as outlined above to consistently meet the angular profile.

12.8.2 Fastener assemblies shall be subject to random profile verification and so documented.

12.8.3 The inspection frequency for obtaining surface profile readings are found in Table 1.

12.8.4 **Note:** When there is evidence of unacceptable surface profile measurements and/or adhesion values associated with failure to the substrate, the Engineer (at no cost to the Department) may require additional development of process control procedures be employed as outlined in the SSPC PA-17 standard (Procedure for Determining Conformance to Steel Profile/Surface Roughness/Peak Count Requirements).

## 12.9 MEK Rub Resistance

12.9.1 Prior to applying the top coats, the MEK resistance of the zinc primer shall be measured in accordance with ASTM D-4752. The MEK rub resistance of the inorganic zinc primer shall meet a minimum rating of 4.

- 12.9.2 Testing shall incorporate alternate surfaces/locations that are subject to top coating.
- 12.9.4 The inspection frequency and location for performing MEK Rub Resistance testing are found in Table 1.
- 12.9.5 **Note:** When there is evidence of ambient conditions and/or air movement not conducive for coating cure, the Engineer (at no cost to the Department) may require additional testing.

#### 12.10 Pencil Hardness

- 12.10.1 Prior to applying the top coats, the film hardness values of the organic zinc primer as determined by the gouge and scratch tests shall be measured in accordance with ASTM D-3363. The hardness values shall meet a minimum of 2H. Should testing reveal unacceptable results, the manufacturers recommendations may be considered and shall be in documented form.
- 12.10.2 Testing shall incorporate alternate surfaces/locations that are subject to top coating.
- 12.10.3 The inspection frequency and location for performing Pencil Hardness testing are found in Table 1.

#### 12.11 Adhesion for Zinc and Coal Tar Applications Employing Pull Off Test Method

- 12.11.1 Prior to applying additional coating layers, the adhesion strength between the zinc primer and steel substrate shall be measured in accordance with ASTM D-4541 and shall meet a minimum of 400 psi.
- 12.11.2 For coal tar epoxy applications, adhesion testing outlined herein is required for both the primer and top coat.
- 12.11.3 Testing shall incorporate alternate surfaces/locations that are subject to top coating.
- 12.11.4 The inspection frequency and location for performing Adhesion testing are found in Table 1.
- 12.11.5 If there is a failure associated with any one test, an additional test is required. If additional failures occur, the coating facility shall document the location and type of failure and provide the Department with a corrective action plan for review and approval.
- 12.11.6 **Note:** When there is evidence of unacceptable surface profile measurements and/or adhesion values associated with failure to the substrate, the Engineer (at no cost to the Department) may require additional development of process control procedures be employed as outlined in the SSPC PA-17 standard (Procedure for Determining Conformance to Steel Profile/Surface Roughness/Peak Count Requirements).

## 12.12 Adhesion for Acrylic Top Coat Applications Employing X-Cut Tape Test Method

- 12.12.1 For final acceptance, the adhesion strength of the acrylic top coat shall be measured in accordance with ASTM D-3359, Test Method A and shall meet a minimum adhesion value of 3A. The frequency and location of testing shall be as specified above for the Pull Off Test Method.
- 12.12.2 Upon successful completion of the adhesion testing (pull-off or tape test), affected surfaces shall be repaired to the satisfaction of the Department.
- 12.12.3 The inspection frequency and location for performing X-Cut Tape Test are found in Table 1.

## 12.13 Drying, Curing, or Film Formation of Organic Coatings

- 12.13.1 Prior to applying additional acrylic coating layers, proper curing shall be determined utilizing the ASTM D-1640 Dry-Through (or Dry-To-Handle) Time Test (Method D). Test results shall ensure that there is no loosening, detachment, wrinkling or other evidence of distortion of the film.
- 12.13.2 Testing shall incorporate alternate surfaces/locations that are subject to top coating.
- 12.13.3 The inspection frequency and location for performing Dry-Through Timetesting are found in Table 1.

## 12.14 Dry Film Thickness

- 12.14.1 Dry film thickness (DFT) measurements shall be obtained on all coating layers and shall incorporate the use of a Type 2 gage as defined in SSPC PA-2.
  - 12.14.1.1 The Type 2 gage shall incorporate probe configurations to compensate for restricted access and part configurations. DFT measurements shall be recorded to the frequency specified in this program and on a form similar to the M&T Form 611 ([Attachment 3](#)).
  - 12.14.1.2 In order to ensure accurate coating thickness measurements and consistent data reporting, QC inspection personnel shall provide Department access to the Base Metal Reading (BMR) adjustment standard and demonstrate the following in the presence in of Department's Quality Assurance representative, unless otherwise approved:
    - 12.14.1.3 Calibration requirements: Pre- and post-verification of accuracy, adjustment of coating thickness measuring gage to be performed using certified standards.
    - 12.14.1.4 Adjustment of the Type 2 gage is to compensate for the BMR which the determined effect of substrate roughness on a coating thickness gage is that is caused by the manufacturing process. Non-compensation for the base metal effect can result in an overstatement of the true thickness of the coating.

- 12.14.1.5 The Type 2 gages need to be adjusted as outlined in Appendix 8 (Mandatory for this program) of SSPC PA-2 to account for the profile of the substrate in order to read the coating thickness directly. The use of smooth steel substrates, to include calibration standards, is strictly prohibited for the use of gage adjustment.
- 12.14.2 For steel products other than pipe piles, QC shall measure and record the dry film thickness (DFT) for all coating layer applications in accordance with Table 1 and SSPC PA-2 Appendix 2, Table A2.2. For Pipe pile members, QC shall measure and record the dry film thickness (DFT) for all coating layer applications in accordance with Table 1 and SSPC PA-2 Appendix 7.
- 12.14.3 **Note:** When there is evidence of gross deviation of work angle, and/or application technique that does not provide specified coverage to bolts, edges, welds and bend radius' the Engineer (at no cost to the Department) may require additional testing.
- 12.14.4 Random locations are defined as equally spaced inspection intervals along the entire length of the member.
- 12.14.5 No spot measurement shall be less than the minimum specified for each coating layer as required in the specified paint system.
- 12.14.6 When a spot reading is non-conforming, the extent of the non-conforming area will be determined by taking additional spot readings not to exceed a one-foot interval in all directions until acceptable spot averages are obtained.
- 12.14.7 Material that does not meet the minimum DFT shall be appropriately identified and repaired in accordance with pre-approved procedures required in Section 442 of the Department's current *Standard Specifications*.
- 12.14.8 As it relates to inorganic zinc applications, dry film thickness readings obtained prior to successful MEK rub tests shall not be considered for final acceptance.
- 12.14.9 The Department may perform additional quality assurance inspection as deemed necessary by the Engineer to ensure that these contract provisions are being met.

## 13.0 COATING REPAIR

- 13.1 All repairs that are performed must meet the requirements of the pre-approved coating repair procedures referenced in Article 442-4 of the *Standard Specifications*.
- 13.2 Coating repairs not addressed in pre-approved repair procedures shall be documented and submitted for review and approval of the Engineer.

**Table 1**

<b>Required Inspection</b>	<b>Test Standard</b>	<b>Location</b>	<b>Frequency</b>
Visual Inspection	ASTM A6 & SSPC SP-10	All Surfaces	100% of all surfaces
Ambient Conditions	ASTM E-337 Test Method B and the U.S. Department of Commerce Psychrometric Tables	At the location where the work is being performed	Prior to final abrasive blast cleaning, prior to each coating application and/or every four hours as conditions change
Abrasive Properties	SSPC AB-1, SSPC AB-2, SSPC AB-3 and/or SSPC PA-17	Prior to first use	As required by SSPC AB-1, SSPC AB-2 and/or SSPC AB-3
Black Iron Fasteners	SP-1 & SP-10	All installed fastener assemblies	100% of all fasteners and prior to blast cleaning
Mechanically or Hot-dipped Galvanized Fasteners	SP-1	All installed fastener assemblies	100% of all fasteners and prior to final blast cleaning and or top-coating
Surface Cleanliness	SSPC SP-10	All coated surfaces	100% visual verification of all surfaces
Surface Profile	ASTM D-4417, Method C	Random surfaces	Obtain a 1.0 to 3.0 mil minimum angular profile. A minimum of two readings per beam/girder, pile (H-pile, sheet pile and/or pipe pile). A minimum of two readings per 10% of materials not included above.
MEK Rub Resistance	ASTM D-4752	Testing shall incorporate alternate surfaces/locations that are subject to top coating	2 tests per 500 ft <sup>2</sup> or less which shall represent inclusively, all materials coated within a single production shift and in the same production area.
Pencil Hardness	ASTM D-3363	Testing shall incorporate alternate surfaces/locations that are subject to top coating	2 tests per 500ft <sup>2</sup> or less
Adhesion	ASTM D-4541, Annex A3 and/or A4 for curved surfaces	Testing shall incorporate alternate surfaces/locations that are subject to top coating	2 (3 dollies per test) tests within a single production shift and in the same production area.
Coating on Faying Surfaces	RCSC, Section 2.5	All contact surfaces	Prior to bolting assembly and/or shipping
Dry Film Thickness	SSPC PA-2 and Section 12 of this document	Each	Per SSPC PA-2 and the applicable appendices for the product type.
Drying, Curing, or Film Formation of Organic Coatings	ASTM D-1640	Testing shall incorporate alternate surfaces/locations that are subject to top coating	5 tests per 250 ft <sup>2</sup> which shall represent inclusively, all materials coated within a single production shift and in the same production area.
X-Cut Tape Test Adhesion	ASTM D-3359	Random surfaces	2 tests per 500ft <sup>2</sup>

	<p><b>North Carolina Department of Transportation</b>                  Division of Highways                  Materials &amp; Tests Unit                  Raleigh, NC 27611</p>	(9/07/2018)	
<b>Notification of Beginning Work Form</b>			
<b>NOTE:</b>	According to Article 1072-7(A), Materials & Test Unit requires 72 hours (3 days) notice for in-state producers and 192 hours (8 days) notice for producers out-of-state		
Date of Notification:		Planned Date to Start Work:	
Name & Phone Number of Producer/Coater Contact Person			
Name of Producer/Coating Contractor			
Location of Producer/Coating Contractor			
Project Number:		Bridge Number:	
Contract Number:		Shop Job Number:	
County :			
<b>Details of Work to Begin</b>			
Completed form should be submitted to the Metals Engineer, Welding Engineer & Coating Engineer (electronically or by mail) at:			
Randy Porter Metals Engineer NCDOT Materials & Tests 1563 Mail Service Center Raleigh, NC 27699 <a href="mailto:srporter@ncdot.gov">srporter@ncdot.gov</a>	Eddie Shelar Welding Engineer NCDOT Materials & Tests 121 Shields Park Drive, Suite E Kernersville, NC 27284 <a href="mailto:gshelar@ncdot.gov">gshelar@ncdot.gov</a>	Aaron Dacey Coating Engineer NCDOT Materials & Tests 1563 Mail Service Center Raleigh, NC 27699 <a href="mailto:ahdacey@ncdot.gov">ahdacey@ncdot.gov</a>	



