

SPECIALTY INSPECTION PROJECTS



Introduction

Non-routine inspection projects can pose special challenges to the coatings inspector. While the classification of a project as “non-routine” or “specialty” is relative to the experience of the inspector, for the purpose of this Module, inspection of shop painting, thermal spray coatings (metallizing), powder coatings and galvanized systems (coating of galvanized surfaces), overcoating, and the disturbance of coatings containing toxic metals are considered to be specialty inspection projects.

Inspecting the surface preparation and coating application in a steel fabrication shop is very similar to inspection in the field; however some of the inspection check points invoked by a field painting specification are not required in the shop. This module describes shop painting operations, industry certification programs and special inspection procedures that may be invoked for work conducted in a fabrication shop, or a blast & paint shop.

Application of thermal spray coatings (TSC) or metallizing requires close attention to surface preparation and oftentimes invokes special inspection procedures for verifying coating thickness. This module describes the metallizing processes and the unique inspection procedures associated with thermal spray coatings.

The use of powder coatings has become more common for new construction, particularly in light of VOC regulations pertaining to the application of liquid-applied products in the shop. This module highlights the special inspection requirements relating to powder coating applications.

Liquid coatings are applied to galvanized steel to provide additional barrier protection, for safety coding or to improve the aesthetics of the galvanizing. These are known as galvanized systems. The special inspection procedures associated with galvanized systems are described in this module.

Maintenance painting strategies range from “do nothing,” to “spot touch-up and overcoat” to complete removal and replacement of the existing coating system. Inspecting overcoating projects presents the inspector with special circumstances, since much of the existing coating will be salvaged, and another coating layer or layers will be applied. This module describes the benefits and risks associated with overcoating, and explains the special inspection requirements associated with overcoating projects.

Many existing industrial steel structures have been painted with coatings that contain toxic metals, including lead, chromium and cadmium. The hazards associated with the removal, handling and disposal of coatings containing toxic metals must be controlled. The inspector may have responsibility for verifying proper set-up and maintenance of containment and ventilation systems; assuring proper worker protection; monitoring air, soil and water quality; and assuring proper handling and disposal of hazardous waste streams. This module describes methods for assessing whether existing coatings contain toxic metals and the possible role of inspection personnel on projects involving disturbance of toxic coatings.

Learning Outcomes

Successful completion of Module 7 will enable the participants to:

1. Describe the special inspection procedures associated with shop painting

2. Describe the special inspection procedures associated with thermal spray coatings, powder coatings and galvanized coating systems.
3. Describe the unique aspects of performing coatings inspection on an overcoating project
4. Describe what the inspector's role might include on projects involving disturbance of coatings containing toxic metals

Coatings Inspection in the Steel Fabrication Shop

The majority of shop painting operations are for new steel members and plates, or for ships, railcars, cranes or other types of equipment



Enclosed Shop

or vessels that have been shop fabricated and primed or fully coated prior to shipment and field installation. However, some shops also prepare and coat steel members (or other components such as hand railings, etc.) that have been disassembled in the field and shipped to a facility that removes the existing coatings and applies a new system. These are often referred to as “blast & paint shops.”

The advantages of shop surface preparation and coating verses field surface preparation and coating can include control over the environment and better access to the steel members before they are erected. However, depending on the type of shop (listed below), controls over the environment may not always occur.



Covered Shop

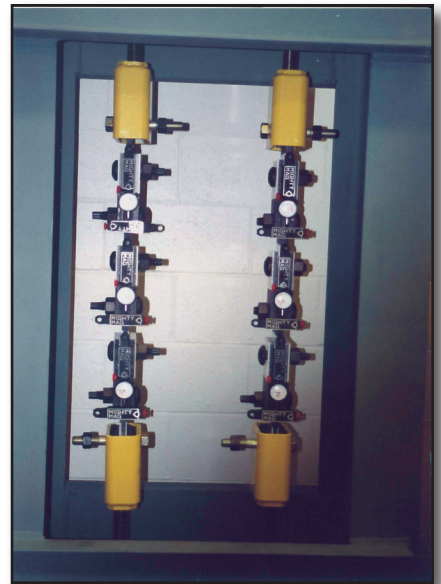
Shops are categorized by SSPC and the American Institute of Steel Construction (AISC) through the certification programs they maintain for fabrication shops that perform surface preparation and painting work. SSPC's Qualification Procedure 3 (QP3) and AISC's Sophisticated Painting Endorsement (SPE) categorize shops into one of four types: Covered Shop, Enclosed Shop, Open Shop and Field.

Coating inspection activities include examination of the steel surfaces prior to surface preparation (known as pre-surface preparation), and inspections of surface preparation and coating application. Most of the inspection check points that are commonly performed for shop work were already described in Modules 3 and 5. Therefore, this section only addresses one new inspection checkpoint that is common to application of coatings in the steel fabrication shop: applying coatings to slip-critical connection points and installation of protective coverings.

Applying Coatings to Slip-Critical Connection Points and Installing Protective Coverings in the Shop



Specifications for coating of beams for buildings, bridges and other structures containing load-bearing members often require the application of primer to the connection points. Depending on the engineering and design of the structure, the selected primer may be required to have a certain resistance to slip. This is known as the Slip Coefficient. Once the beams are bolted together (using gusset plates or other structural steel connectors) and the bolts are torqued, the connections cannot slip under load; otherwise the bolts may shear and the connection may break. Coatings help give these connections added resistance to slip. Traditionally, zinc-rich primers were used on these slip-critical connections; however other coatings have been developed with similar slip resistant properties. Prior to application in the shop, the specific manufacturer and product must be tested in a laboratory for resistance to slip. Testing is performed according to Appendix A of the *Specification for Structural Joints Using ASTM A325 or A490 Bolts*, prepared by the Research Council on Structural Connections. Some project specifications will require the primer to maintain a Class B slip rating (minimum 0.50 slip



Tension Creep Test

coefficient), while others will allow a lower rating (Class A, minimum 0.33 slip coefficient).

There are two concerns for an inspector when inspecting the coatings applied to these slip-critical connections. First, the thickness, the type and amount of thinner, and the minimum cure time prior to bolting, are all critical

variables. These variables are included in the testing and certification processes, and are reported on the Certificate. The inspector must verify that these same variables are used during the application of the coating in the



Masked areas at bolted connection points

shop to the slip critical connection points. The same type and amount of thinner (if any) identified on the certification must be used, and the thickness of the applied film must be carefully controlled according the specification requirements (which often require a lower film build in the joints). Application of a build-up coat or reducing the applied thickness by sanding or “screening” in these areas should not be permitted. When the thickness of the primer in these areas does not conform to the specification, it should be removed and reapplied. The primer must be allowed to cure for the minimum amount of time listed on the certification or the project specification (whichever is longer), prior to bolting connections. The inspector should verify that all of these procedures are carefully followed by the fabrication shop.

Secondly, once these connection points are primed, the specification will typically require that the connection points be protected from subsequent applications of intermediate or finish coats. The inspector should verify that protective covering are properly installed in these areas and that they are maintained throughout the finishing process.

Inspection of Thermal (Metallized) Spray Coatings (TSC)

The terms metallizing or metallized spray may be used to describe the coating. Metallizing may be used as a noun to refer to the type of coating, or as a verb to refer to the application method for the coating. Metallized is used as an adjective for the process (spray method) or type coating. There are three basic forms of metallized spray, including flame spray, electric arc spray and plasma spray. Plasma arc spray is not generally used for coating of structural steel or concrete. Arc spray is the most common (and most productive) of the three methods, and is typically the method employed in the shop or field for metallizing both new and existing industrial structures. Metallizing can be applied to both steel and concrete surfaces. In general, a metal wire or metal powder is fed into an application device (spray gun), melted, then atomized and blown to the surface of the structure using compressed air. The wire or powder can be made from a variety of metals and is selected based on the service environment and intended level of performance (the same way liquid-applied coatings are selected). The metals and alloys most commonly used on industrial structures (for corrosion protection) include zinc, aluminum, and an 85% zinc and 15% aluminum alloy. SSPC, NACE and the American Welding Society (AWS) developed a “tri-society” guide (SSPC CS 23.00/AWS C 2.23M/NACE No. 12, “Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for the Corrosion Protection of Steel”), which describes the requirements of metallizing and provides guidance on inspection procedures that are employed on projects incorporating metallized spray. Brief descriptions of the three metallizing processes are provided in this section. The SSPC Painting Contractor Certification Program (PCCP) Qualification Procedure 6 (QP6), “Standard Procedure for Evaluating the Qualifications of Contractors Who Apply Thermal Spray (Metallizing) for Corrosion Protection and Steel and Concrete Structures” qualifies contractors performing metallizing work, which may be a prerequisite requirement of eligibility to bid a metallizing project. Note that the installation of metallizing can be more labor intensive and more costly than traditional liquid-applied coatings and linings. Metallizing is not a forgiving coating and may fail catastrophically if the surface is not prepared properly (a “White Metal Blast” per SSPC SP 5/NACE 1 is

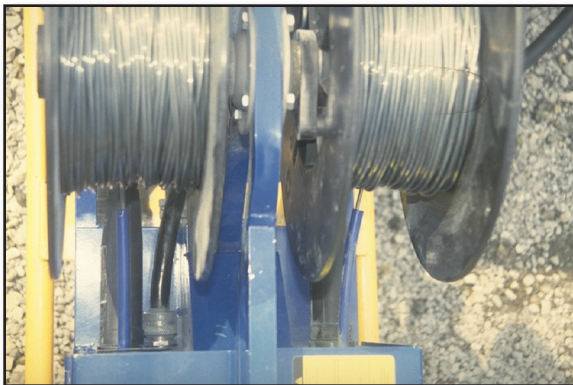
specified for marine and immersion service, along with a minimum 64 μm (2.5 mil) angular surface profile). Any residual dust or debris on the surface, an inadequate surface profile depth or a peened surface texture, or poor quality compressed air can cause delamination of the metallized film. Flexibility (bend) testing and tensile (pull-off) adhesion testing (described later in this module) are routinely performed as part of the inspection process to help assess proper installation. There is no wet film measurements or solvent emissions from metallizing. The dry film thickness must be routinely measured using electronic gages (described later in this module) during the application, as soon as the surface cools.

Electric Arc Spray Metallizing

Electric arc spray metallizing uses relatively high electrical amperage to melt wire, rather than a flame. Two wires are fed from individual spools into a spray gun. Each wire is given an opposing electrical charge between 375 and 400 amps. As the wires feed into the gun, they contact, arc and melt. Compressed air atomizes the molten metal wire and blows it onto the surface. The spray fan is wider than that of flame spray, and is generally more productive.



Electric Arc Spray



Arc Spools



Arc Spray Gun

Flame Spray Metallizing

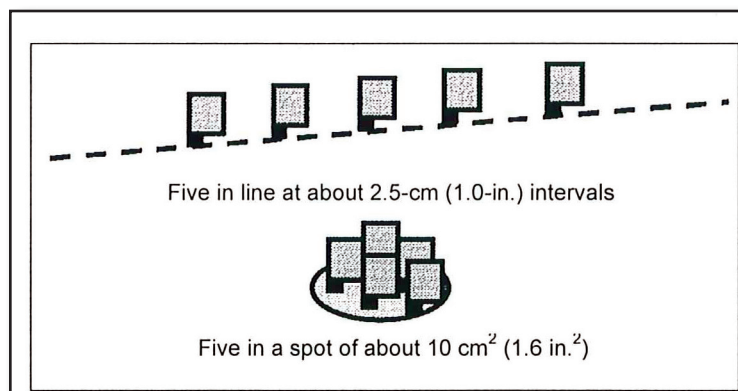


Flame spray metallizing employs an oxygen-acetylene generated flame to melt a spool-driven wire (as it exits the spray gun). Once the wire is melted, compressed air atomizes the molten metal wire and blows it onto the surface. The spray fan is only approximately 50 cm (2 inches) wide, and the spray distance is typically maintained at 200 cm (4 inches), making flame spray application very labor intensive (and oftentimes cost-prohibitive) for large projects. Flame spray can be economical for metallizing small areas and for repairing/rebuilding metal components subject to cavitation erosion.

Measuring the Thickness of Thermal Spray Coatings

Measuring the thickness of thermal spray coatings (TSC) is somewhat different than for liquid-applied coatings. While the same types of gages (Type 1 or Type 2) are used to measure thermal spray coatings, the frequency of measurements and the number and location of individual gage readings is different.

Section 6.2 of the tri-society guide (SSPC CS 23.00/AWS C 2.23M/NACE No. 12, described earlier in this module) provides a thickness measurement schedule for thermal spray coatings. The thickness is measured by employing a “measurement line” for flat surfaces and a “measurement spot” for complex geometries and geometry transitions. These measurement procedures are illustrated in the figure below. For flat surfaces, a minimum of five individual gage



Line and Spot Measurements

readings are taken in line at 2.5 cm (1 inch) intervals. The individual gage readings are averaged to generate a line reading. The line measurement technique measures the inherent “peaks and valleys” of the TSC. For complex geometries and geometry transitions, a minimum of five individual gage readings are taken in a spot, with an area of approximately 10 cm² (1.6 inches²). The individual gage readings are averaged to generate a spot reading. The spot measurement technique may not measure the inherent “peaks and valleys” of the TSC. One line or spot measurement is obtained every 10 to 20 m² (100-200 ft²) of applied TSC.

The thickness of the TSC should be specified as a range. If the thickness of the TSC is less than the minimum required by the contract documents, then the applicator must apply additional TSC to meet the thickness requirements. If the thickness of the TSC is greater than the maximum allowed by the contract documents, the information should be recorded by the inspector and the owner notified of the non-conforming areas. TSC thickness in excess of 150% of the maximum specified thickness should be recorded. If these areas are damaged during loading, transport, unloading or erection, they must be repaired using procedures described in ANSI/AWS C2.18.

Inspection of Powder Coatings

Powder coatings films are created when finely pulverized plastics (that are different from conventional liquid coatings) are applied to prepared steel surfaces and fused together by heat. The powders may be thermoplastics or thermosets. Thermoplastics melt, flow and form a film with no change in chemical composition. They are often applied as thick films. Examples include polyethylene, polypropylene, nylon, polyvinyl chloride and thermoplastic polyesters. Conversely, thermosets melt, flow and cross-link during curing. They can be applied as thinner films. Examples include epoxy, acrylic, polyurethane and hybrids. Perhaps the most common thermoset powder coating is the fusion-bonded epoxy, or FBE. Powder coatings are applied using fluidized beds, electrostatic spray, hot flocking and thermal spray, and are used to protect appliances, outdoor furniture, farm implements, lamp housings, rebar, piping and building products.

Inspection of powder coating application includes the powder material itself, surface preparation, curing, appearance, thickness and discontinuity (holiday/pinhole detection). For thick film powder coatings applied to pipe and other substrates that may be subject to impact damage, a hardness test may be required.

The inspector typically verifies proper storage of the powder material, just as he would liquid coatings, including clean and dry areas that are maintained within the manufacturer's specified ranges for temperature and humidity. The manufacturer and type of powder, and the batch or lot no. should be recorded. The currency of the shelf life of the batch should also be verified prior to use.

The coatings inspector will also verify that the degree of surface cleanliness (e.g., ISO Sa 2 ½ or SSPC-SP10/NACE No. 2) and the depth of surface profile (1-3 mils; 25-75 µm) meets the requirements of the project specification (if abrasive blast cleaning is required by the contract documents). These inspection procedures were described in Module 3. Conversion coatings such as iron phosphate, zinc phosphate, and certain chromates can be used to enhance the adhesion of powder coatings and/or to provide corrosion protection. The coatings inspector may be required to monitor the application of the conversion coatings prior to application of the powder coating.

The coatings inspector may verify conformance to the powder manufacturer's curing procedures, including oven dwell time and temperature, the substrate type and the temperature of the coated part. Specially formulated thermosetting powder coatings may use ultraviolet (UV) light, rather than heat to cure the film.

Finally, the powder coated item can be visually inspected for overall appearance (uniformity of color and gloss, texture, handling damage, etc.), coating thickness (per SSPC-PA 2 or ASTM D 7091); discontinuities, holidays or pinholes (per ASTM D 5162 or NACE RP0188) and Durometer hardness (ASTM D 2240) on powder coated pipe and other substrates subject to impact damage during installation. Other methods for assessing cure (pencil hardness per ASTM D 3363) may also be invoked by the powder coating manufacturer or the contract documents. These inspection procedures were described in Module 5.

Inspection of Galvanized Systems

Galvanizing is a coating comprised of nearly 100% zinc. It can be applied to steel surfaces by a variety of methods including hot dip, electrodeposition and tumbling (limited primarily to fasteners).

Hot-dip galvanizing is done in a galvanizing shop. Prepared steel is dipped into a molten bath of 98% pure zinc with a layer of flux floating on the top of the liquid. The temperature of the bath is maintained at 850°F. The thickness of the galvanizing layer deposited on the piece is based on the dwell time in the bath. The thickness of hot dip galvanizing can be measured with a non-destructive dry film thickness gage (galvanizing is conductive, but it is not magnetic). Typically the deposition rate is 2.1-2.9 ounces per square foot, which equates to approximately 3.5-5.0 mils. Approximately 50% of the layer is zinc metal, while the other 50% is a zinc-iron alloy.

As soon as a galvanized surface is exposed to the atmosphere, the surface begins to change to form a zinc oxide layer. When moisture is present, the layers change to zinc hydroxide. When the zinc hydroxide reacts with carbon dioxide in the air, a layer of zinc carbonate forms. This layer is tightly bonded to the underlying galvanizing. The condition of the galvanizing layer dictates the level of preparation prior to applying a liquid coating. Thoroughly weathered galvanizing only requires minor hand or power tool cleaning to remove rough areas, and perhaps pressure washing to remove loose zinc oxide. These conditions are considered optimum for applying a liquid coating to galvanizing.

New galvanizing or galvanizing that has not had an opportunity to weather is very difficult to coat, as the solvents in the coating cannot penetrate the galvanizing layer and no mechanical bond is formed. A chromate layer may also be present (to preserve the galvanizing), which can inhibit adhesion of a liquid coating. Attempts to wash the surface with vinegar are futile. Careful sweep blasting using a mildly aggressive abrasive in accordance with SSPC SP 16 (also known as dust blast cleaning) to roughen (but not remove) the galvanizing layer is often required (effectively creating an etched surface to produce a mechanical bond). The application of chemical treatments and/or conversion coatings which etch the galvanizing are also employed,

but may be less practical and pose certain health hazards. Polyvinyl butyral wash primers were widely used in the past; however these products are high in volatile organic compounds (VOC) and contain toxic pigments (chromium), so their use has declined in recent years.

Some consider coating of galvanizing as a “belt and suspenders” approach to corrosion control. However, the application of a liquid applied coating to the galvanizing is analogous to topcoating a zinc-rich primer. The coating provides the primary protection, while the galvanizing provides secondary protection as the liquid coating deteriorates over time. The galvanizing is the “last line of defense” against corrosion of the underlying steel. This system is called a “galvanized system.” In addition, requirements for the use of safety colors and improved aesthetics (appearance) are accomplished by coating the galvanized surfaces.

The most common coating systems for application to properly prepared galvanized surfaces include epoxy primers (with polyurethane finish coats for exterior service) and two-coat waterborne acrylic systems. Other types of coatings may be able to be used, however the coating manufacturer must be included in the decision-making process to ensure compatibility with the galvanizing and to provide any special requirements for surface preparation. SSPC Guide 19, *Selecting Coatings for Use Over Galvanized Substrates*, assists owners and specifiers in selecting an appropriate coating for protection of galvanized surfaces exposed to aggressive environments.

Inspection of coatings for galvanizing (and related surface preparation) is similar to that described in Modules 3 and 5. The inspector may be responsible for verifying removal of grease and oil contamination (per SSPC-SP1), monitoring blast pressure during sweep blasting using a hypodermic needle pressure gage (to ensure that the pressures are not too aggressive), and may visually inspect the surfaces for the degree of roughening. The mixing, thinning and application inspection procedures associated with the liquid-applied coating system are no different than described in Module 5. Note however that all Type 1 and Type 2 dry film thickness gages will include the thickness of the galvanizing when measurements of the liquid-applied coating are obtained. The inspector will need to obtain base measurements of the galvanizing layer (after surface preparation), or measure the thickness of the coating using a destructive gage. One Type 2 gage manufacturer

(Fischer Technology, Inc.) manufactures a gage that will display the thickness of the galvanizing layer and the coating layers individually when assessing the thickness of a galvanized system.

Inspecting Overcoating Projects

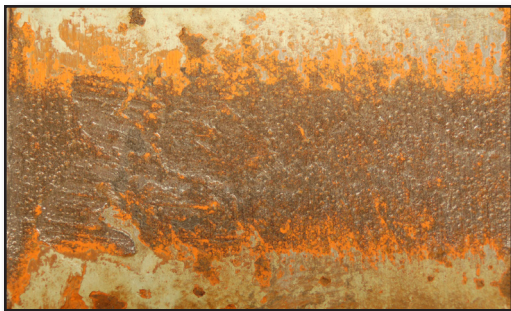
Overcoating is defined by SSPC Technology Update No. 3 (Overcoating) as *the practice of painting over an existing coating as a means of extending its useful service life*. Overcoating can be a cost-effective alternative to total removal and replacement of the coating system, particularly when the existing system contains toxic metals like lead, cadmium or chromium. There are risks associated with overcoating that should be carefully considered by the facility owner before preparing a project specification and bidding the work. For example, if the existing system has marginal or poor cohesive or adhesive strength, it may not be able to withstand the stresses imparted by additional coating layers and may catastrophically fail. Therefore, adhesion testing (described in Module 5) should be undertaken prior to determining the maintenance strategy. Other factors should also be considered, including the condition of the substrate, the thickness of the existing system and the amount of repair work required prior to overcoating. Finally, the generic type of the existing system should be identified, so that a compatible overcoating material can be selected. In some cases, test patches of various coating systems and types of surface preparation are installed, aged for as long as feasible (preferably 6 to 12 months to include weather cycles), then examined for defects (e.g., delamination, peeling, blistering, cracking, checking, corrosion, etc.) and tested for adhesion of the coating layers to one another and to the substrate. Installation of test patches is described in SSPC Guide 9 and in ASTM D5064.

The decisions regarding the maintenance strategy and coating system selection are outside the responsibilities of the coating inspector, and are oftentimes made long before an inspector becomes involved with a project. If overcoating is the strategy selected by the facility owner/specifier, then the inspector may need to perform certain non-routine check points, since the existing system will become part of the new system. This section only describes those inspections that would not normally be required on total coating removal and replacement projects, or on projects involving new steel. Routine inspection check points like measurement of ambient conditions and surface

temperature, and witnessing of mixing, thinning and application techniques must be performed, independent of the maintenance strategy invoked by the specification. These inspection check points are not described in this section, since they were already covered in previous modules.

Surface Preparation

Various types and degrees of surface preparation are invoked by specifications for overcoating projects. Independent of the surface preparation method(s) specified, the inspector should first verify that all visible grease and oil contamination has been removed in accordance with SSPC-SP1. Areas on the structure exhibiting peeling, flaking coating or areas of corrosion are typically repaired on a spot basis. Hand or power tool cleaning (ISO St2/St3 or SSPC-SP2/SP3) may be required to remove loose rust or paint. Commercial Grade Power Tool Cleaning (SSPC-SP15) or Power Tool Cleaning to Bare Metal (SSPC-SP11) may be invoked if the specifier desires a cleaner surface, or if a surface profile is required in the repaired areas. Abrasive blast cleaning may be specified for spot repair, with recognition that there is the potential for overblast damage from stray abrasive. The areas of sound coating adjacent to the repair areas should be feathered to provide a smooth transition for the touch-up and overcoat materials, and to prevent lifting of the existing coating along the edges of the spot repairs. Feathering can be accomplished



Feathered Coating

by hand sanding, or using various power tools described in Module 3. Once the spot repairs are completed, the inspector should verify that the specified degree of surface cleanliness has been achieved (using the SSPC Visual Standards), and that feathering has been performed in the spot repair areas.

Areas of intact coating can be roughened by brush-off abrasive blast cleaning (SSPC-SP7/NACE No. 4) or light blast cleaning (ISO Sa1), then visually inspected using ISO 8502 or SSPC VIS 1. However, there is a chance that the existing coating may be fractured during the blast cleaning operation, which may lead to failure once the overcoat system is applied. Therefore, the contractor may be required to lower blast pressures, extend the nozzle-to-surface distance, and use a minimally-aggressive abrasive to

prepare the existing surfaces. The inspector may be required to verify that the correct blast pressures and abrasive type are being used by the contractor. Blast pressure can be measured using a hypodermic needle pressure gage described in Module 3. If brush-off or light blast cleaning is specified, the inspector must carefully examine the prepared areas for fracturing or other defects that may compromise the overcoating strategy. Post-blast adhesion testing may also be required to assess the integrity of the existing coating.

The specification may invoke pressure washing (SSPC-SP WJ/NACE WJ Waterjet Cleaning Standards 1 Through 4) using water pressures up to 35 MPa (5000 psi) to remove chalking, loose paint, dirt, bird droppings and other surface debris from the existing coating. In this case, the inspector will need to touch the surface and perform a visual inspection to verify that these materials have been adequately removed from the surfaces, and not simply transferred to a different location on the surface. Oftentimes the surface must be wiped or brushed during the washing process to remove dirt and chalking paint, just like a sponge is used when washing a car to aid in removal of the surface dirt, rather than relying solely on water pressure for cleaning. When washing coatings that contain toxic metals, the wash water and debris will typically be collected. The wash water can be filtered and reused, or filtered and sent to a publicly owned water treatment works (POTW) for disposal. Hazardous landfills will not accept liquid waste. Water and debris from pressure washing operations may not be permitted to contact water or soils surrounding the project site, or enter storm sewers. The inspector may be responsible for verifying proper containment and handling of pressure washing waste. Additional information on inspecting projects involving disturbance of toxic metal coatings is provided later in this module.

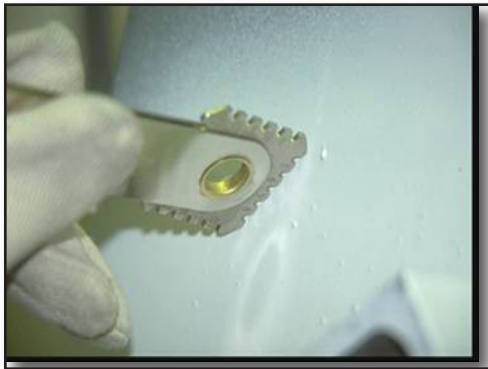
If the existing coating was exposed to chemicals, salt deposits from a coastal environment or deicing materials during service, the specification will typically require soluble salt extractions and analysis (after surface preparation) to verify adequate removal of the salt contamination. Methods of extracting and analyzing samples

for soluble salts (chloride, ferrous ion, sulfate and/or nitrates) were described in Module 3.



Measuring the Thickness of the Existing Coating

Since the majority of the existing coating will remain on the structure, the inspector may be required to obtain thickness measurements on the existing coating, so that the thickness of the overcoat can be isolated from the thickness of the existing coating when using nondestructive dry film thickness gages. Oftentimes however, the thickness of the existing coating is highly variable, and would require mapping to identify the area and the corresponding thickness in that area. This process can be quite time consuming and may not provide the degree of accuracy needed. Alternatively, the thickness of the new coating can be measured at locations of bare steel that are integrated throughout the existing coating. Other methods of isolating the thickness of the overcoat material from the thickness of the existing coating (like the Tooke Gage described in Module 5) are destructive to the coating film, but are more reliable.



Measurement of Wet Film Thickness

If the thickness of the existing coating is highly variable and if destructive coating thickness measurements are not desired, then the contractor and inspector may have to rely on wet film thickness measurements of the overcoat material to determine conformance to the project specification. Use of a notch-type wet film thickness gage was described in Module 5. Since wet film thickness will be the only indicator of film build, the inspector should ensure that the target wet film thickness is properly calculated (based on the target dry film thickness, the volume solids content of the overcoat and the quantity of thinner added to the overcoat material). These formulas were described in Module 5. Even if dry film thickness measurements will be taken, the applicator should monitor the wet film thickness of the overcoat, just as he would during any coating application operation.

Measurement of Dry Film Thickness

The dry film thickness can be measured nondestructively or destructively. If nondestructive gages are employed, the gage will indicate the thickness of the existing coating and the overcoat, since these gages cannot distinguish coating layers. Therefore, the thickness of the existing coating in each area must be known and deducted from the gage reading to isolate the thickness of the overcoat, or the thickness readings taken on areas where bare steel was exposed prior to overcoating. If the coating is inspected using nondestructive methods, the gage must be verified for accuracy (in the range of use, which includes the existing coating and the overcoat thicknesses) prior to and after use. The frequency of thickness measurements should conform to SSPC PA 2 or ASTM D7091 if either of these test methods is invoked by the project specification.

For greater accuracy, the thickness of the overcoat material can be measured using a Tooke Gage or other brand of destructive coating thickness gage. Use of a Tooke Gage was described in Module 5. Note that the overcoat material must be a different color than the topcoat of the existing coating system, otherwise the coating layers may be indistinguishable. While the standard that governs the use of the Tooke Gage (ASTM D4138) does not prescribe a frequency for measurements, the frequency prescribed by SSPC PA 2 may be adopted. Note that it may not be necessary to obtain three gage readings at each spot, since the number of incisions through the coating should be minimized. Also, it is not necessary to scribe down through all coating layers to the substrate, since the goal is to assess the thickness of the overcoat application and not the entire system. This will minimize damage and prevent possible corrosion of the exposed steel in the cut area. Independent of the depth of the incisions, the cut areas should be touched-up (typically by brush application) once the measurements are made. The inspector should verify that the scribed areas are touched-up prior to the contractor demobilizing from the project site.

Assessing Adhesion

The project specification may require the inspector to assess the adhesion of the overcoat material to the existing coatings (and the entire system to the substrate) to verify that the adhesion is similar

to that obtained in a pre-job the test patch, or to verify adequate adhesion if a test patch was not installed and evaluated. Adhesion can be assessed using the knife/tape method (ASTM D3359), the knife method (ASTM D6677) or the pull-off method (ISO 4624 or ASTM D4541 for steel or ASTM D7234 for concrete). Since adhesion testing is destructive to the coating, the number of tests should be minimized and the test areas should be touched-up by the contractor. The procedures for assessing the adhesion of coatings were described in Module 5.



Inspecting on Projects Involving Removal of Toxic Metal Coatings

Older structures are often painted with coatings that contain toxic metals. These toxic metals typically include lead, cadmium and hexavalent chromium. Lead and hexavalent chromium were used as corrosion inhibitors in coating formulations, and cadmium provided coatings with bright color. These metals can pose a hazard to humans and to the environment when they are disturbed during maintenance painting operations. Specifications for projects involving the disturbance of toxic coatings require the contractor to control the hazards during surface preparation operations. This includes installation and maintenance of containment and ventilation systems, worker protection and medical surveillance, environmental monitoring and hazardous waste management. ***It is beyond the scope of this course to provide comprehensive training on each of these items. SSPC offers a 32-hour curriculum on deleading of industrial structures (SSPC C3) and offers annual refresher training (SSPC C5) for those already qualified through the SSPC C3 program. This section provides a brief overview of worker and environmental protection and monitoring on projects involving coatings that contain toxic metals.***

The contractor is responsible for providing a trained “competent person” on the project site for controlling the hazards associated with the disturbance of toxic metal coatings. The contractor’s competent person is responsible for worker protection, environmental protection and management of the waste streams. The competent person is

ultimately responsible for implementing the written, site-specific compliance program throughout the course of the project.

As an inspector, **if you are trained and if it is part of your scope of services**, you may be responsible for verifying the adequacy of the containment system, for verifying that the contractor and his personnel are complying with the site plans they developed to meet the regulations, and for verifying that the hazardous waste being generated on the project is being properly handled, stored and transported.



Containment on Dam Gate

Containment and Ventilation

Containment systems are used on structures to prevent the debris that is generated during surface preparation activities from contaminating the air, soils and water surrounding the project site - to protect the public health and welfare. Since the debris is concentrated inside the containment, ventilation systems are employed to protect the workers inside the containment. Ventilation is recognized as an engineering control to reduce worker exposures to toxic metals. SSPC Guide 6 on containment and ventilation describes four “classes” of containment for each of two removal methods (dry abrasive blast cleaning, and wet abrasive blast cleaning/water jetting) and three containment classes each for power tool cleaning and chemical stripping. The components of the containment and ventilation systems for each of the four classes and removal methods are described in SSPC Guide 6. The guide also provides information on the methods used to verify the effectiveness of the containment, including air, soils and water sampling and analysis. The tables which display the various containment and ventilation components for each class are appended to this module. An SSPC Class 1 containment provides the highest level of environmental protection, while



Air Handling Unit/Dust Collector

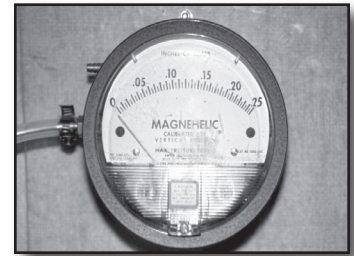


Containment under negative pressure

an SSPC Class 3 or 4 containment provides the lowest level of protection. The specification will dictate the level of containment and ventilation required.

As an inspector, you may be required to verify that the containment (as built) and the air movement inside the containment meet the requirements of the project specification. The project specification may also invoke monitoring of the air, soils and/or water on the project site to verify the adequacy of the containment during cleaning and painting operations. Inspectors are sometimes required to collect pre- and post-project water and soil samples, and to operate high volume air samplers during surface preparation activities. Since the inspector will not routinely be inside the containment during surface preparation, he may be required to monitor the exterior of the containment for visible emissions.

The higher classes of containment often invoke negative pressure as a means to prevent dust from exiting the containment. Specifications may require measurements of negative pressure using a magnehelic gage, which detects and displays the pressure differential between the inside and outside of the containment. A typical negative pressure specified for Class 1 containments is 0.03 inches water column relative to ambient conditions. The inspector may be responsible for verifying negative air pressure, or visually verifying that the containment walls are drawn inward when the dust collection system is operational.



Magnehelic Gage



Rotating Vane Anemometer

Air flow inside the containment can be measured using rotating vane anemometers. Proper ventilation includes properly sized dust collectors and adequate make-up air entryways (ports). Ventilation rates vary, but cross-draft ventilation of 30 meters (100 feet)/minute or down draft ventilation of 18 meters (60 feet)/minute are often specified.

Air quality outside of the containment can be monitored using high volume air monitors, by conducting visible emissions monitoring, or both. There are two types of high volume air monitors: ones that sample respirable particulate (aerodynamically 10 μ m and smaller



TSP Monitor

in diameter) using a size-selective inlet known as PM-10 monitors; and ones that sample total airborne particulate, known as Total Suspended Particulate or TSP monitors. These monitors are sited around the project area, and their placement is based on prevailing wind direction, height and length of the structure, proximity of the structure to sensitive receptors such as schools, day care centers and residential housing and other factors. The monitors are fitted with a filter about the size of a sheet of paper and a known volume of air is drawn across the filter. Airborne particulate is collected on the filter paper. The filter is removed from the air monitor daily and shipped to a qualified laboratory (with a properly completed chain-of-custody) for analysis. PM-10 filters are typically analyzed gravimetrically for weight gain, while TSP filters are typically analyzed for lead. The results of the analysis are compared to the specification requirements for the maximum amount of particulate matter or toxic metals allowed. Background



PM10 Monitor

monitoring (before a project begins) is oftentimes conducted to establish “normal” levels of particulate or toxic metals in the air.



Soil sampling

Pre- and post-project soil sampling and analysis may be conducted to determine whether paint removal operations contributed to background levels of toxic metals already in the soil. A 0.1 square meter (1 square foot) template is used to collect 5 soil plugs (one from each corner and from the center, 0.5” deep x 0.75” diameter) which comprise a single soil sample. The post-project soil samples must be collected from the exact same location as those collected before the project begins, otherwise the post-project results cannot be compared to the background levels. Soil samples are sent to an approved laboratory (with a properly completed chain-of-custody form) and analyzed for the toxic metals of interest. If the inspector collects or witnesses the collection of soil samples, the date of collection and the sample collection sites must be recorded. Oftentimes a site map is drawn with the location of the soil samples plotted. Alternatively,

because of the variability in test results depending on where the samples are taken as well as the nature of the sample (e.g., a small paint chip in the sample can skew the results), visual inspections have become more common. In this case, the work site is evaluated visually for the presence of paint chips or surface preparation debris, which is removed by the contractor prior to demobilization.



Water sampling

Similarly, water and sediment can be visually assessed, or samples may be collected and analyzed to determine whether paint removal operations contributed to background levels of toxic metals already in the water. Water sampling is of little use in a stream or river unless the water is slow moving and very shallow. Otherwise any debris that was deposited in the water will be carried off by the current long before post-project water samples are obtained. Water samples must be collected using clean containers (e.g., glass jars) containing a small amount of nitric acid to keep any metals suspended in the water sample. Water samples are sent to an approved laboratory (with a properly completed chain-of-custody form) and analyzed for the toxic metals of interest. If the inspector collects or witnesses the collection of water samples, the date of collection and the sample collection sites must be recorded.



Worker properly protected

Many specifiers require the contractor to prepare and submit a site-specific environmental protection program, which must be reviewed and accepted prior to commencing work. The inspector may be required to verify the contractor's compliance to the written plan throughout the project.

Worker Protection

Exposure monitoring is conducted early in the project to measure airborne levels of toxic metals generated by the paint removal operations. The results of the exposure monitoring dictate the level of respiratory protection required, after all engineering controls and work practices are implemented. Establishment of a regulated area,

medical surveillance, hygiene facilities, protective clothing, training, and written compliance programs are also required of the contractor. Many specifiers require the contractor to prepare and submit a site-specific worker protection program, which must be reviewed and accepted prior to commencing work. The inspector may be required to verify the contractor's compliance to the written plan throughout the project.



Regulated Area

The inspector should not enter the containment to perform inspection of surface preparation until it is well-ventilated. Even then, protective clothing and respiratory protection should be worn. The inspector should never eat, drink or use tobacco products in the regulated area, and should use the hand wash and shower facilities, as applicable, on the project site.



Waste Storage Area

Managing Hazardous Waste

The contractor is often required to properly handle, store and transport hazardous waste that is generated on a painting project. Waste includes spent abrasive and paint debris, empty paint cans, spent solvent, contaminated containment or ground tarps and disposable protective clothing. The project specification will indicate the requirements for storage and transport of waste materials generated

on the project site. Many specifiers require the contractor to prepare and submit a site-specific waste management program, which must be reviewed and accepted prior to commencing work. The inspector may be required to verify the contractor's compliance to the written plan throughout the project, including all waste handling procedures (hazardous and non-hazardous) and maintenance and security of the waste storage area.

Samples of abrasive/paint debris are collected by the contractor and shipped to a laboratory to determine whether the debris is hazardous.

The laboratory analyzes the samples for leachable toxic metal content using the Toxicity Characteristic Leaching Procedure (TCLP) test. Samples are analyzed for eight different toxic metals. If the concentration of any of the eight metals exceeds EPA limits, then the waste is categorized as hazardous and must be properly transported, treated and disposed of. Other characteristics of the waste such as ignitability, corrosivity, and reactivity are also used to classify a waste as hazardous.

Hazardous waste can only be transported by licensed haulers and can only be treated and disposed of by licensed hazardous waste treatment facilities. The inspector may be required to ensure waste drums are properly labeled and waste manifests are properly completed. The facility owner is the generator, but the contractor can be named as a co-generator of the waste. One or both parties have “cradle-to-grave” responsibility for the waste, and can be heavily fined or imprisoned for violating hazardous waste regulations.

Note that the contractor may elect to use (or the specification may require the use of) proprietary additives (sprayed onto the surface prior to abrasive blast cleaning or combined with the abrasive by the supplier) which can render the waste stream non-hazardous by the TCLP test procedure. SSPC Guide 7 on disposal provides additional guidance on hazardous waste management procedures.

Summary

In Module 7, we have described the special inspection requirements involved with shop painting, thermal spray coatings (metallizing), powder coatings and galvanized coating systems, overcoating projects and projects involving the disturbance of coatings containing toxic metals.

Surface preparation and coating application inspection in a steel fabrication shop or a “blast & paint” shop is similar to field inspection. SSPC QP3 and AISC SPE categorize shops into four types—Covered Shop, Enclosed Shop, Open Shop and Field—and both qualification and certification programs require implementation of quality control procedures and documentation. Special inspection procedures for inspecting the application of primers to slip-critical connections and the installation of protective covering were also described.

Metallized spray incorporates a wire or a powder that is melted using an oxygen-acetylene flame (flame spray) or electric arc (arc spray). The molten metal is then atomized and transferred to the surface using compressed air. SSPC, NACE and AWS have developed a guide (SSPC CS 23.00/AWS C 2.23M/NACE No. 12) for application of metallized coatings and SSPC has established a contractor certification procedure (QP 6) for metallizing application companies. Metallizing is not a “surface tolerant” coating and requires a White Metal Blast (SSPC-SP5/NACE No. 1) for immersion or severe exposure environments and a 64-75 μm (2.5-3 mil) angular surface profile for proper adhesion. A “Near-White” blast (SSPC-SP10/NACE No. 2) is normally adequate for non-severe environments. Flexibility and adhesion testing are inspection check points which are often invoked above and beyond the normal inspection check points associated with a coating installation.

Powder coatings films are created when finely pulverized plastics (that are different from conventional liquid coatings) are applied to prepared steel surfaces and fused together by heat. The powders may be thermoplastics or thermosets. The coatings inspector may verify surface preparation (cleanliness, roughness or pretreatment processes), and conformance to the powder manufacturer's application and curing procedures. Powder coated items are visually inspected for overall appearance, thickness, discontinuities, and hardness.

New galvanizing or galvanizing that has not had an opportunity to weather is very difficult to coat. Careful sweep blasting using a mildly aggressive abrasive to roughen the galvanizing layer is often required. The application of a liquid applied coating to the galvanizing provides the primary protection, while the galvanizing provides secondary protection as the liquid coating deteriorates over time. This system is called a "galvanized system." The inspector may be responsible for verifying removal of grease and oil contamination, monitoring blast pressure during sweep blasting, and may visually inspect the surfaces for the degree of roughening. Traditional dry film thickness gages will include the thickness of the galvanizing when measurements of the liquid-applied coating are obtained. One Type 2 gage will display the thickness of the galvanizing layer and the coating layers individually.

Overcoating is a maintenance strategy that can be employed by a facility owner to reduce costs by extending the life of the existing coating system, versus the cost of totally removing and replacing the coating. There is risk associated with overcoating, so the existing coating system must be carefully evaluated to assess whether it is a candidate for overcoating. The assessment includes tests for substrate condition, amount of corrosion and deterioration present, the thickness and adhesion of the existing coating, and the generic type of the existing coating. Test patches can be applied and evaluated prior to full scale overcoating when the condition of the existing coating is marginal. Surface preparation inspection includes verification of oil/grease removal per SSPC-SP1, and inspection of spot touch-up areas for cleanliness, roughness (if required) and proper feathering of the existing coating for a smooth transition. The remaining surfaces may be brush blasted or pressure washed. These surfaces must be inspected to ensure the existing coating was not severely fractured, and that surface dirt, chalk and other debris has been adequately removed.

Testing for chemical contamination may also be required, if soluble salts were deposited onto the surfaces while in service. The inspector may be required to measure and map the thickness of the existing coating, and may be required to measure the wet film thickness of the overcoat material during application. The final dry film thickness can be measured either nondestructively or using a destructive gage. If a nondestructive gage is used, the thickness of the existing system must be deducted from the measurements in order to isolate and document the thickness of the overcoat, or the readings taken in spots where the existing coating had been totally removed. Adhesion of the overcoat to the existing system may be assessed to ensure that the overcoat is properly bonded, and is similar to the adhesion characteristics of the coating system on a test patch, if one was prepared. Areas where destructive coating thickness and/or adhesion testing were performed should be touched up by the contractor to prevent premature rusting in these areas.

The inspector's role on projects involving removal of coatings containing toxic metals (primarily lead, cadmium and hexavalent chromium) can include inspecting the effectiveness of the containment system by monitoring the air, soils and water around the project site, and by performing visible emissions (VE) monitoring during surface preparation activities. Air quality is monitored by VE observation, or by employing high volume air sampling for total suspended particulate or respirable particulate. Soil and water quality is monitored by collecting and analyzing pre- and post-job samples, or visually. The inspector may also be responsible for verifying that the contractor and his personnel are conforming to their site plan for complying with the recommended comprehensive health standard(s) for the toxic metal(s) in the coating, including the implementation of engineering controls, work practices and respiratory protection to control the hazard. The inspector may also evaluate the effectiveness of the ventilation system by measuring air movement inside the containment. Likewise, the inspector should follow the same rules as the contractor's personnel regarding protective clothing, respiratory protection and use of hygiene facilities on the project site.

Finally, the inspector may be responsible for verifying that the contractor is handling and storing all of the waste (hazardous and non-hazardous) properly, and that the waste is tested by an approved laboratory and hauled from the site by a licensed transporter. The inspector may be asked to review the contractor's site-specific, written worker protection, environmental protection and waste management compliance plans prior to production work, and may be required to verify conformance to the written plans during production work.

**TABLE A – ABRASIVE BLAST CLEANING
COMBINATIONS OF CONTAINMENT AND VENTILATION SYSTEM COMPONENTS**

Containment Classification	Containment System					Ventilation (5.4 of SSPC-Guide 6)				
	5.3.1 Containment Materials	5.3.2 Penetrability	5.3.3 Support Structure	5.3.4 Joints	5.3.5 Entryway	5.4.1 Air Make-Up	5.4.2 Input Air Flow	5.4.3 - Air Pressure	5.4.4 Air Movement	5.4.5 Exhaust Dust Filtration
Class 1A	A1 - Rigid A2 - Flexible	B1- Air Impenetrable	C1- Rigid C2 - Flexible	D1- Full Seal	E1- Airtlock E2 - Resealable	F1- Controlled	G1- Forced G2 - Natural	H1- Instrument Verification H2- Visual Verification	I1- Minimum Specified	J 1- Air Filtration
Class 2A	A1- Rigid A2 - Flexible	B1- Air Impenetrable	C1- Rigid C2 - Flexible	D1- Full Seal	E2 - Resealable E3 - Overlap	F1- Controlled F 2 Open	G1 – Forced G 2 - Natural	H2 -Visual Verification	I1- Minimum Specified	J 1- Air Filtration
Class 3A	A1- Rigid A2 - Flexible	B1- Air Impenetrable B2a - Air Penetrable (Tightly Woven)	C1- Rigid C2 - Flexible	D1- Full Seal D2 - Partial Seal	E3 - Overlap E4-Open Seam	F1- Controlled F 2 Open	G1- Forced G2 - Natural	H3 – Not Required	I2 - Not Specified	J 1- Air Filtration
Class 4A	A1- Rigid A2 - Flexible	B2a and B2b - Air Penetrable	C3 - Minimal	D2 -Partial Seal	E4-Open Seam	F2 - Open	G2 - Natural	H3 – Not Required	I2 - Not Specified	J2 - No Controls on Exhaust

Note 1: The information in this table is provided for guidance only and does not guarantee that any specific levels of containment will be achieved by following the suggestions. The type of structure, wind conditions, soundness of the materials of construction, and many other factors play a role in containing dust and debris.

Note 2: The table occasionally identifies two options for a given component. For example, containment materials (5.3.1) are shown as being either rigid or flexible. If the specifier requires the use of rigid materials only, this restriction must be specified separately.

Note 3: The design suggestions made in this table are based on the use of open abrasive blast cleaning inside containment with expendable abrasives. The classifications are ordered from the greatest degree of dust and debris containment (Class 1A) to the least (Class 4A). Normally, the higher the degree of containment, the higher the costs. Many other combinations of the components beyond those suggested above can be used to provide similar results. The method of preparation can also be adjusted to reduce or eliminate dust emissions.

Note 4: Certain combinations of components within each class may not be suitable when removing hazardous paints (e.g., forced air input in combination with penetrable containment materials in Class 4A).

Note 5: When designing a ventilation system, care must be taken to balance the static pressure with the input airflow to avoid collapsing the containment due to high negative pressure.

* When vacuum shrouded blast cleaning is employed, ground covers and/or free hanging tarpaulins may provide controls equivalent to Class 1A.

**TABLE W – WATER BLASTING/WATERJETTING*
COMBINATIONS OF CONTAINMENT AND VENTILATION SYSTEM COMPONENTS**

Containment Classification	Containment System					Ventilation (5.4 of SSPC-Guide 6)				
	5.3.1 Containment Materials	5.3.2 Penetrability	5.3.3 Support Structure	5.3.4 Joints	5.3.5 Entryway	5.4.1 Air Make-Up	5.4.2 Input Air Flow	5.4.3 - Air Pressure	5.4.4 Air Movement	5.4.5 Exhaust Dust Filtration
Class 1W	A1 - Rigid A2 Flexible	B1- Air Impenetrable AND B3a - Water Impermeable	C1- Rigid C2 - Flexible	D1- Full Seal	E2 - Resealable	F2 - Open	G1 - Forced G2 - Natural	H2 -Visual Verification	I1- Minimum Specified	J1- Air Filtration
Class 2W	A1 - Rigid A2 - Flexible	B3a - Water Impermeable	C1- Rigid C2 - Flexible	D1- Full Seal	E3 - Overlap	F2 - Open	G2 - Natural	H3 - Not Required	I2 - Not Specified	J2 - Not Required
Class 3W	A1 - Rigid A2 - Flexible	B3a - Water Impermeable	C3 - Minimal	D2 - Partial Seal	E4-Open Seam	F2 - Open	G2 - Natural	H3 - Not Required	I2 - Not Specified	J2 - Not Required
Class 4W	A1 - Rigid A2 - Flexible	B3b - Water Permeable	C2 – Flexible	D-2 Partial Seal	E4- Open Seam	F2 - Open	G2 - Natural	H3 - Not Required	I2 - Not Specified	J2 - Not Required

Note 1: When designing a ventilation system, care must be taken to balance the static pressure with the input airflow to avoid collapsing the containment or ductwork due to high negative pressure.

Note 2: The table occasionally identifies two options for a given component. For example, containment materials (5.3.1) are shown as being either rigid or flexible. If the specifier requires the use of rigid materials only, this restriction must be specified separately.

Note 3: Class 4W will capture dislodged paint chips and debris, but will not contain the water used for cleaning.

* When vacuum shrouded waterjetting is employed, ground covers or free-hanging tarpaulins may provide controls equivalent to Class 1W.

**TABLE P – POWER TOOL CLEANING*
COMBINATIONS OF CONTAINMENT AND VENTILATION SYSTEM COMPONENTS**

Containment Classification	Containment System					Ventilation (5.4 of SSPC-Guide 6)				
	5.3.1 Containment Materials	5.3.2 Penetrability	5.3.3 Support Structure	5.3.4 Joints	5.3.5 Entryway	5.4.1 Air Make-Up	5.4.2 Input Air Flow	5.4.3 - Air Pressure	5.4.4 Air Movement	5.4.5 Exhaust Dust Filtration
Class 1P	A1 - Rigid A2 Flexible	B1- Air Impenetrable	C1- Rigid C2 - Flexible	D1- Full Seal	E2 - Resealable	F1 - Controlled	G1 - Forced G2 - Natural	H2 -Visual Verification	I1- Minimum Specified	J1- Air Filtration
Class 2P	A1 - Rigid A2 Flexible	B1- Air Impenetrable B2a or B2b - Air Penetrable	C1- Rigid C2 - Flexible	D1- Full Seal	E3 - Overlap E4 - Open Seam	F2 - Open	G2 - Natural	H3 - Not Required	I2 - Not Specified	J2 - Not Required
Class 3P	A1 - Rigid A-2 Flexible	B2a or B2b - Air Penetrable	C3 - Minimal	D2 - Partial Seal	E4 - Open Seam	F2 - Open	G2 - Natural	H3 - Not Required	I2 - Not Specified	J2 - Not Required

Note 1: When designing a ventilation system, care must be taken to balance the static pressure with the input air flow to avoid collapsing the containment or ductwork due to high negative pressure.

Note 2: The table occasionally identifies two options for a given component. For example, containment materials (5.3.1) are shown as being either rigid or flexible. If the specifier requires the use of rigid materials only, this restriction must be specified separately.

* For hand tool cleaning or vacuum shrouded power tool cleaning, ground covers or free-hanging tarpaulins may provide controls equivalent to Class 1P.

**TABLE C – CHEMICAL STRIPPING
COMBINATIONS OF CONTAINMENT AND VENTILATION SYSTEM COMPONENTS**

Containment Classification	Containment System					Ventilation (5.4 of SSPC-Guide 6)				
	5.3.1 Containment Materials	5.3.2 Penetrability	5.3.3 Support Structure	5.3.4 Joints	5.3.5 Entryway	5.4.1 Air Make-Up	5.4.2 Input Air Flow	5.4.3 - Air Pressure	5.4.4 Air Movement	5.4.5 Exhaust Dust Filtration
Class 1C	A1- Rigid A2 Flexible	B1- Air Impenetrable AND B3a - Water Impermeable AND B4-Chemical Resistant	C1- Rigid C2-Flexible	D1- Full Seal	E3 - Overlap	F2 - Open	G1 - Forced G2 - Natural	H3 - Not Required	I2 - Not Specified	J1- Filtration
Class 2C	A1- Rigid A2 Flexible	B3a - Water Impermeable AND B4-Chemical Resistant	C1- Rigid C2-Flexible	D1- Full Seal	E3 - Overlap	F2 - Open	G 2 - Natural	H3 - Not Required	I2 - Not Specified	J2 - Not Required
Class 3C	A1- Rigid A-2 Flexible	B3a – Water Impermeable AND B4-Chemical Resistant	C3 - Minimal	D2 - Partial Seal	E4 – Open Seam	F2 - Open	G2 - Natural	H3 - Not Required	I2 - Not Specified	J2 - Not Required

Note 1: When designing a ventilation system, care must be taken to balance the static pressure with the input airflow to avoid collapsing the containment or ductwork due to high negative pressure.

Note 2: The table occasionally identifies two options for a given component. For example, containment materials (5.3.1) are shown as being either rigid or flexible. If the specifier requires the use of rigid materials only, this restriction must be specified separately.

Note 3: When pressure washing is used to remove the dislodged paint, it may be necessary to specify one of the containments from Table W for the control of the water and waste.

	Module Seven
	Specialty Inspection Projects

	Introduction
	■ Non-routine or specialty coating inspection projects can present special challenges ■ “Non-routine or specialty” is relative to the inspector’s experience ■ Module addresses: ➢ Special inspection procedures relating shop painting ➢ Inspection of thermal spray coatings (TSC) ➢ Inspection of powder coatings ➢ Inspection of galvanized coating systems ➢ Inspection of overcoating projects ➢ Inspection on projects involving toxic metal coatings

	Module Seven Learning Outcomes
	■ Comprehension of Module Seven will enable the participant to: ➢ Describe the special inspection procedures associated with shop painting ➢ Describe the special inspection procedures associated with TSC, powder coatings and galvanized coating systems ➢ Describe the unique aspects of performing coatings inspection on an overcoating project ➢ Describe what the inspector’s role might include on projects involving disturbance of coatings containing toxic metals

	Coatings Inspection in the Steel Fabrication Shop
	■ Shop painting operations generally for new steel, or ships, railcars, vessels, etc. ■ Some shops prepare and coat components removed from the field (“blast & paint shops”) 

	Coatings Inspection in the Steel Fabrication Shop
	■ SSPC and AISC categorize shops through certification programs (SSPC QP3 and AISC SPE) ■ Four types of shops ➢ Covered ➢ Enclosed ➢ Open ➢ Field

	Coatings Inspection in the Steel Fabrication Shop
	■ SSPC QP3 and AISC SPE require: ➢ Qualified QC personnel ➢ Inspection equipment ➢ Written and implemented procedures for inspection and documentation

Coatings Inspection in the Steel Fabrication Shop

- Coating inspection activities include:
 - Pre-surface preparation inspection
 - Surface preparation inspection
 - Coating application inspection
 - Described in Modules 3 & 5

Applying Coatings to Slip-Critical Connection Points

- Specifications for coating of building beams, bridges, etc. (load-bearing members) often require primer at connection points
- Selected primer may be required to be resistant to slip (slip coefficient)
- Once bolted and torqued, connections cannot slip (or bolts may shear)
- Some coatings help resist slip under load

Applying Coatings to Slip-Critical Connection Points

- Lab Test:
 - Coating (often zinc-rich) must be tested for slip coefficient
 - *Specification for Structural Steel Joints using A325 or A490 Bolts (appendix A)*
- Field Test:
 - Inspector must verify:
 - Thickness of coating
 - Amount and type of thinner used (if any)
 - Minimum cure time prior to bolting
 - All listed on certification supplied by coating manufacturer

Applying Coatings to Slip-Critical Connection Points

- Application of build coats and screening typically prohibited
- Once primed, verify connection points are protected (masked)



Thermal Spray Coatings

- A coating (noun) and an application method (verb)
- Flame Spray
- Electric Arc Spray (most common)
- Plasma Spray (not common)
- For Steel and Concrete
- Wire or powder selected
- Melted, atomized and blown to surface
- Common wire for industrial/marine structures
 - Zinc
 - Aluminum
 - 85%/15% Zinc/Aluminum Alloy

Thermal Spray Coating Standards

- SSPC-AWS-NACE Tri-Society Specification SSPC CS 23.00/AWS C 2.23M/NACE No. 12
- SSPC PCCP QP6 (thermal spray coating contractor qualification) (shop or field)

Thermal Spray Coatings

- Typically more labor intensive and costly than liquid-applied coatings
- Not a “forgiving” coating
- SSPC-SP5 White Metal Blast (marine & immersion service); minimum 64 µm (2.5 mil) angular surface profile
- Dust, debris or peened surface profile can cause delamination
- Clean, dry compressed air required for atomization

Thermal Spray Coatings

- Flexibility (bend tests) and adhesion testing routinely performed
- No wet film thickness measurements
- No solvent emissions
- Dry film thickness measurements as soon as surface cools

Thermal Spray Coatings

- Flame spray
 - Single wire fed into spray gun
 - Acetylene/oxygen flame melts wire
 - Compressed air blows melted metal onto surface



Limitations of Flame Spray

- Distance to work surface cannot exceed 100 mm (4 inches)
- Spray pattern relatively small (50 mm, or 2 inches)
- Slow
- Can be useful for rebuilding eroded metal

Thermal Spray Coatings

- Electric arc spray
 - Two wires fed into spray gun
 - Wires are given opposing electric charges (375-400 amps)
 - Wires cross, arc, melt
 - Compressed air blows melted metal onto surface



Measuring Thickness of Thermal Spray Coatings

- Thickness of TSC measured differently than liquid-applied coatings
 - Same gages (Type 1, Type 2)
 - Frequency and number of readings varies from SSPC PA2
 - Thickness measurement schedule in Section 6.2 of tri-society guide (SSPC CS 23.00/AWS C 2.23M/NACE No. 12)

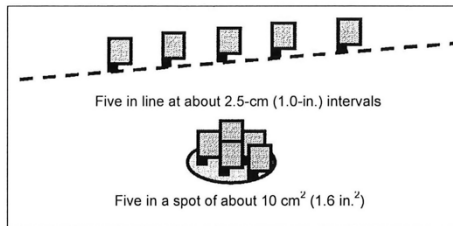
Measuring Thickness of Thermal Spray Coatings

- **Measurement “Line” for flat surfaces**
 - Minimum 5 gage readings obtained in line (2.5 cm or 1 inch intervals)
 - Average of 5 readings is a line measurement
 - Line measurement technique assesses inherent “peak/valley” of TSC

Measuring Thickness of Thermal Spray Coatings

- **Measurement “Spot” for complex surfaces**
 - Minimum 5 gage readings obtained in spot (area of 10 cm² or 1.6 in²)
 - Average of 5 gage readings is a spot measurement
 - Spot measurement technique does not assess inherent “peak/valley” of TSC

Measuring Thickness of Thermal Spray Coatings



Measuring Thickness of Thermal Spray Coatings

- TSC thickness should be specified as a range
- Thickness less than specified: apply additional TSC
- Thickness greater than specified: record thickness and locations; notify owner
- Thickness > 150% of maximum requires repair if damaged (ANSI/AWS C2.18)

Inspection of Powder Coatings

- **Powder coatings:**
 - Pulverized plastics applied and fused with heat or UV light
 - Thermoplastic and thermosetting
 - Applied by fluidized bed, electrostatic spray, hot flocking and thermal spray

Inspection of Powder Coatings

- **Inspection checkpoints:**
 - Powder material storage and condition
 - Shelf life verification
 - Record of batch no's.
 - Surface cleanliness and profile depth
 - Monitor application of conversion coatings (if used) prior to powder coating

Inspection of Powder Coatings (con't.)

- Inspection checkpoints:
 - Verify curing procedures (dwell time; temperature; substrate type and temperature) if heat is employed
 - Appearance of finish
 - Coating thickness
 - Discontinuities (holidays/pinholes)
 - Hardness and cure (if required)

Inspection of galvanized Systems

- Galvanizing
- Applied by:
 - Electro-deposition
 - Hot dip (shown)
 - Tumbling (fasteners)



Hot-Dip Galvanizing

- Performed in a shop
- Prepared steel dipped in molten zinc bath (454°C/850°F)
- Thickness determined by bath “dwell time”
- Thickness measured using nondestructive magnetic DFT gage
- Deposition Rate: 2.1-2.9 oz./sq. ft.
 - 89-127 microns (3.5-5.0 mils)

The Changing Surface of Galvanizing

- Exposure to atmosphere causes formation of zinc oxides (ZnO_2)
- Moisture changes ZnO_2 to zinc hydroxide (ZnOH)
- ZnOH reacts with CO_2 and changes to zinc carbonate
 - Tightly bonded to underlying galvanize layer

Preparing Galvanizing for Coating

- Weathered galvanizing:
 - Hand or power tool cleaning
 - Pressure washing
 - Considered “optimum” surface for coating
- New galvanizing:
 - Difficult to coat
 - Requires sweep blasting
 - Chemical treatments/conversion coatings available
 - Wash primers rarely used today

Coating Systems for Galvanizing (SSPC Guide 19)

- Known as “galvanized system”
- Coating provides primary protection
- Galvanizing provides secondary protection as primary protection deteriorates
- Liquid coatings provide color for safety and/or aesthetics

Coating Systems for Galvanizing (SSPC Guide 19)

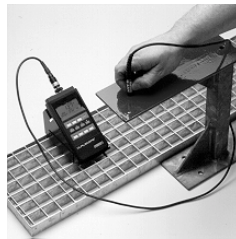
- Common coating systems:
 - Epoxy primer (with polyurethane finish for exterior service)
 - Two-coat waterborne acrylic
 - Others (consult with coating manufacturer for compatibility and surface preparation requirements)

Inspection of Coating Application to Galvanized Steel

- Removal of grease/oil (SSPC-SP1)
- Monitoring blast pressure (for sweep blasting)
- Verify proper roughening
- Mixing, thinning and application of liquid coatings

Inspection of Coating Application to Galvanized Steel

- Measuring dry film thickness of galvanized systems
 - Most gages indicate combined thickness
 - Measure coating thickness destructively
 - Fischer Technology gage displays individual layers



Inspecting Overcoating Projects

- Overcoating defined by SSPC TU 3
 - *The practice of painting over an existing coating as a means of extending its useful service life*
- Can be cost-effective when existing coatings contain toxic metals

Inspecting Overcoating Projects

- Risk associated with overcoating:
 - Adhesive/cohesive strength of existing coating is poor
 - Substrate contains mill scale or extensive rusting
 - Excessive thickness of the existing system
 - Amount of repair work required is extensive
 - Incompatible overcoat

Inspecting Overcoating Projects

- Install test patches, when feasible:
 - Age 6 to 12 months
 - Examine for defects
 - Test adhesion
 - Installation per SSPC Guide 9 and ASTM D5064

Inspecting Overcoating Projects

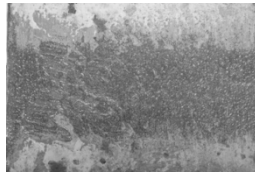
- Maintenance strategy decisions not typically the inspector's role
- If overcoating is the strategy, special inspection checkpoints may be invoked
- The existing coating becomes part of the new system

Inspecting Overcoating Projects

- Surface Preparation
 - Verify grease/oil removal (per SSPC-SP1)
 - Verify repair areas prepared per specification
 - SSPC-SP2/SP3 (ISO St2/St3)
 - SSPC-SP11/SP15
 - May invoke abrasive blast cleaning
 - Potential for over blast damage

Inspecting Overcoating Projects

- Intact coating can be brush blast cleaned (ISO Sa 1;SP7/NACE 4)
- May fracture aged coating
 - Special abrasives
 - Monitor nozzle distance
 - Lower blast pressures
 - May require post-blast adhesion testing
- Spot repaired areas may require feathering



Inspecting Overcoating Projects

- Surface Preparation, con't.
 - Specification may invoke pressure washing (SSPC-SP WJ/NACE WJ Waterjet Cleaning Standards 1 through 4)
 - Verify removal of dirt, chalking, loose coatings and rust, bird debris
 - Surfaces may require agitation during washing
 - Wash water may require collection and filtration
 - Specification may invoke surface soluble salt extraction and analysis prior to overcoating

Inspecting Overcoating Projects

- Measure existing coating thickness
 - Often highly variable
 - May require mapping (time consuming)
 - Options:
 - Measure thickness of applied coating in repair areas (no existing coating)
 - Measure thickness using destructive gages (e.g., Tooke Gage)



Inspecting Overcoating Projects

- Measuring Wet Film Thickness
 - Use notch-type gage
 - Verify WFT target is calculated properly
 - Measure WFT even if DFT will be measured



Inspecting Overcoating Projects

- Measure Dry Film Thickness
 - Deduct existing coating thickness, or
 - Measure where bare steel was exposed (repair areas)
 - Verify gage accuracy
 - Measure per SSPC PA2 or ASTM D7091
 - Document thickness data



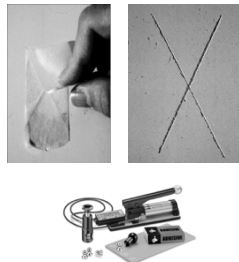
Inspecting Overcoating Projects

- Measure Dry Film Thickness
 - Use Tooke Gage (ASTM D4138)
 - Layers must be different colors
 - Scribe through overcoat only
 - Frequency per SSPC PA2 or ASTM D7091
 - Document thickness data
 - Verify repair of cut areas



Inspecting Overcoating Projects

- Assess Adhesion
 - Verify similar to test patch or acceptability (if no test patch installed)
 - Knife/tape (ASTM D3359)
 - Knife (ASTM D6677)
 - Pull-off (ISO 4624, ASTM D4541 or D7234)
 - Verify repair of test areas



Inspecting on Projects Involving Removal of Toxic Metal Coatings

- Older structures may contain toxic metal coatings
 - Lead
 - Hexavalent chromium
 - Cadmium
- Pose a hazard to workers, the public and the environment



Inspecting on Projects Involving Removal of Toxic Metal Coatings

- Specifications require control of hazards
 - Installation of containment & ventilation systems
 - Worker protection & medical surveillance
 - Environmental monitoring
 - Hazardous waste management
- Comprehensive training provided in SSPC C3 and C5 courses
- Contractor responsible for providing trained "competent person"
- Inspectors may have responsibility for verification of adequate worker, environmental protection and proper waste handling

Containment & Ventilation

- Containment systems prevent debris from contaminating environment (protect public health & welfare)
- SSPC Guide 6
 - Classes of containments for various surface preparation methods
 - Class dictated by specification
 - Guide 6 includes methods to evaluate effectiveness of containment
 - Tables appended to Module 7



Containment & Ventilation	
■ Ventilation of containment: ➢ Reduces worker exposure levels ➢ Maintains negative pressure to reduce opportunity for emissions	

Containment & Ventilation	
■ Inspector may have on-site responsibility to verify: ➢ Proper class of containment (as built) ➢ Air movement meets specification ➢ Effectiveness of containment - Air monitoring - Visible emissions monitoring - Soil monitoring - Water/sediment monitoring	

Containment & Ventilation	
■ If inspector is required to verify proper containment and ventilation, inspectors should be trained in SSPC C3 or similar course	

Worker Protection	
■ OSHA has comprehensive health standards for lead, hexavalent chromium and cadmium ■ Potential for worker exposure during surface preparation operations ■ OSHA requires implementation of engineering controls, work practices and respiratory protection when airborne levels exceed the Action Level	

Worker Protection	
■ OHSAS 18001 ➢ Developed to be compatible with the ISO 9001 (Quality) and ISO 14001 (Environmental) management systems standards, in order to facilitate the integration of quality, environmental and occupational health and safety management systems by organizations	

Worker Protection	
■ Inspector should not enter containment until well-ventilated ■ Wear respiratory protection & protective clothing ■ Never eat, drink or smoke inside regulated area ■ Use hygiene facilities after inspections and end of shift	

	Summary
	■ Reviewed special inspection requirements for: ➢ Shop painting ➢ Thermal spray coatings ➢ Powder coatings ➢ galvanized coating systems ➢ Overcoating projects ➢ Projects involving disturbance of coatings containing toxic metals

	Summary (con't.)
	■ Shop Coatings Inspection ➢ Listed classifications of shops ➢ Described requirements for application of coatings to slip-critical connections ■ Inspection of Thermal Spray Coatings ➢ Described application methods ➢ Reviewed inspection check points

	Summary (con't.)
	■ Inspection of Powder Coatings ➢ Described application processes ➢ Reviewed inspection check points ■ Inspection of galvanized Systems ➢ Described hot-dip galvanizing ➢ Described procedures used to prepare galvanizing for coating ➢ Listed common coating systems used over galvanizing ➢ Reviewed inspection check points

	Summary (con't.)
	■ Overcoating Projects ➢ Described the advantages and risks associated with overcoating ➢ Described inspection check points associated with overcoating projects

	Summary (con't.)
	■ Projects involving disturbance of coatings containing toxic metals ➢ Described the inspector's role ➢ Described the purpose of containment and ventilation systems ➢ Described methods for verifying containment effectiveness ➢ Described methods to verify ventilation effectiveness

	Summary (con't.)
	➢ Described the hygiene and personal protection rules for inspection personnel ➢ Described the requirements for waste handling